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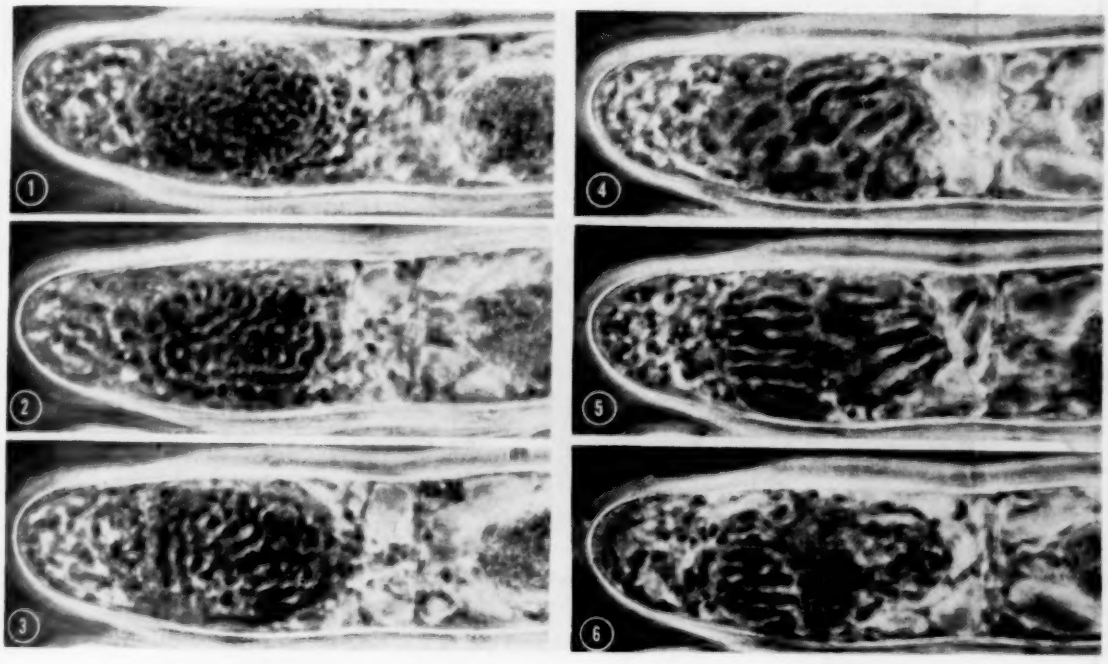

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Cover Photograph

This beautiful set of photomicrographs is the work of Dr. Clarence Flaten, Indiana University. Mitosis is shown in the terminal cell of a staminal hair of Tradescantia ohioensis. The time span is two and one-half hours. Prophase is shown in figures 1-3, metaphase in 4, anaphase in 5, and the beginning of plate formation in 6.

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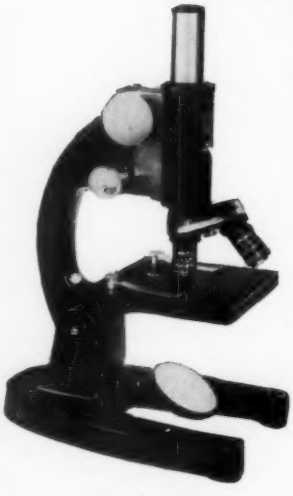

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Ten Classroom Sessions in Ecology[1]

HOWARD T. ODUM
Institute of Marine Science, The University of Texas, Port Aransas, Texas

Oceanography, forestry, management of ranges, fisheries, wildlife, streams, pollution, limnology, biogeochemistry, hydrology, sanitary engineering, and many other subjects[2] are on the long list of areas of science and technology concerned with man's survival and management of the planet. These are branches of environmental science. In today's fierce competition any societal system which survives will be one with a sustained system for utilizing the environmental resources. Education of a generation of leaders who can use the environments effectively is a major need.

Just as basic English must serve the educational needs of students who later enter hundreds of different occupations with varied, heavy responsibilities of literacy, so the science in the schools must be of a basic nature to permit students to understand the essentials of the multiplicity of advanced and applied subjects in an ever more complex age of science.

The basic science concerned with the environment is ecology, the study of environments (forests, fields, lakes, seas, reefs, aquarium systems, living capsules for space, etc.). In this article are set out some fundamentals of ecology along with ten practical class exercises for the school. These exercises in basic ecology are introduced as a replacement for the miscellaneous comments on environment in many school texts.

The practical exercises are also selected to show through actual student participation some essentials of the scientific process such as comparison of hypotheses and results, relating two functions on a graph, statistical use of replications, the controlled experiment, the use of analogue thinking, the making of generalizations, the combined use of methods of several sciences, the use of instrumental measurements, and the combined use of detailed experiments and maps to understand big phenomena.

In this article some key diagrams and supplementary notes are presented for use on the blackboard with each exercise. The background readings are to be found elsewhere (Odum and Odum, 1959). The ten figures were taken from ten lantern slides used to present a lecture on the teaching of ecology at an AIBS meeting. The ten figures may again be used for this same purpose in textbooks or in education classes in the college. By addition or subtraction of supplementary details of varying difficulty, these exercises may serve to start environmental science wherever it is first given whether in the grammar school or the graduate school.

Class 1—Basic Concepts, The Ecosystem, The World Balance (Figure 1)

On the first day the principles of the balanced earth and the balanced aquarium are presented. It is shown that products of respiration exactly complement photosynthesis and vice versa. The two great energy laws are illustrated, (1) conservation of energy, and (2) degradation of concentrated energy types into unusable, dispersed, heat. It is especially important to show that all the reac-

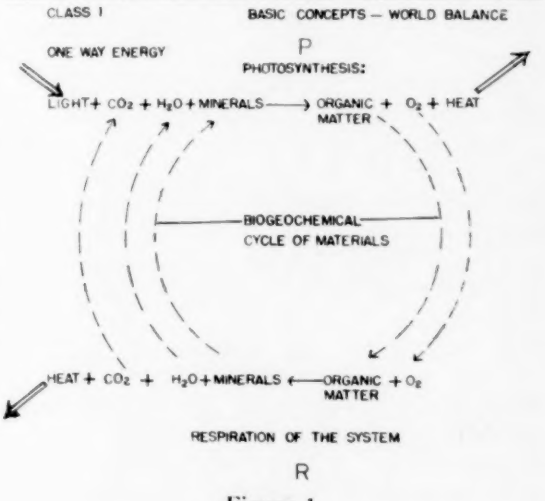
CLASS 1
BASIC CONCEPTS — WORLD BALANCE
ONE WAY ENERGY
P
PHOTOSYNTHESIS:
LIGHT + CO_2 + H_2O + MINERALS → ORGANIC MATTER + O_2 + HEAT
BIOGEOCHEMICAL CYCLE OF MATERIALS
HEAT + CO_2 + H_2O + MINERALS ← ORGANIC MATTER + O_2
RESPIRATION OF THE SYSTEM
R

Figure 1

[1]This paper was presented at the NABT sessions meeting with the AIBS at Pennsylvania State University, August, 1959.

[2]The word conservation sometimes implies a disuse.

tions involve degradation of energy. The usual school texts, that show energy on one side of a reaction only are very misleading about energy resources which are important to our survival. In the discussion the teacher can elaborate with specific examples, mention systems that do not balance, estimate quantities involved per acre per day, enumerate names of organisms involved in the different processes, list the mineral substances, and specify mechanisms of circulation. Then he may introduce the word *ecosystem* as the name for the functioning environments which usually have (a) photosynthesis, (b) respiration, and (c) biogeochemical circulation.

Class 2—An Ecosystem Example, Field Trip to a Fish Pond (Figure 2)

Next an outdoor pond ecosystem is visited. Large organisms are collected with a dip net. Plankton nets are made by the students by tieing a bottle in the toe of a stocking whose upper end is pinned or sewed on a coat hanger rim. A cloth bag like a sugar sack can also be used. When this net is pulled through the water on a string, the water goes through the cloth, but flea-sized organisms stay in the bottle. Hold the bottle to the light to see them or bring them back to the room and pour them into an open bowl to watch. Try to find some evidence of the microscopic suspended algae which go through cloth. When abundant, the water is green, although silt also makes water look green. The algae are the principal photosynthesizers although the big plants help some too. Use a minnow seine and husky boys to pull through the shallows to get small fish, snails, and water insects.

After some collecting is done in this way, the teacher draws the class together and tells a story about the inflow of light energy—taking note of the depth that photosynthesis can occur by noting the depth that a stick can be observed. Explain how the hidden algae make the food; the flea-size animals eat it; and the rest of the larger creatures eat the little animals. Then pull up some black, bottom mud on a stick and explain that the bacteria are decomposing the left-overs and releasing the minerals and carbon-dioxide for another round. Show how the wind waves supply the circulation. Show how photosynthesis is in the top of the pond and much of the respiration is in the lower levels of water and bottom mud. Indicate that the pond is a typical ecosystem; refer back to the ideas introduced in Class 1. Try to keep the boys from becoming overconcerned with the fish. Make them see the ecosystem more than creatures. Explain that the great oceans are built and work almost in the same way.

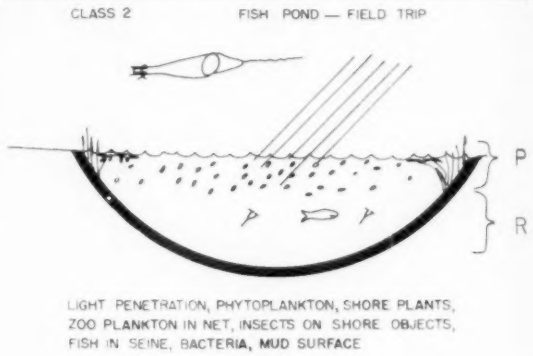
CLASS 2
FISH POND — FIELD TRIP
P
R
LIGHT PENETRATION, PHYTOPLANKTON, SHORE PLANTS,
ZOO PLANKTON IN NET, INSECTS ON SHORE OBJECTS,
FISH IN SEINE, BACTERIA, MUD SURFACE

Figure 2

Class 3—Preparation of Microcosms, Little Laboratory Ecosystems (Figure 3)

In the third session some of the water and live materials collected from the pond ecosystem are used for the construction of several types of little systems in the classroom. One kind has more animals than can be supported by plants as in the usual aquarium full of fish. Respiration exceeds photosynthesis ($R > P$); oxygen comes in from the air continuously. Another type without big animals is fertilized with some plant nutrients, such as Vigoro or other fertilizer from the dime store, and placed in bright light. After one to two weeks of growth such a system has more photosynthesis than respiration ($P > R$). To start these systems, seed them with the collections from outdoors and wait to see what the microcosms will produce. Each will be different. Apply the same ideas as in the previous sessions in order to understand the functions. Systems with circulation supplied with a stream of bubbles will be different from the ecosystems with less circulation. Systems that are closed up tight with plastic sheets except for necessary light will approach a balance ($P = R$). Making such aquarium systems has been a custom in schoolrooms for years, but these systems need to be studied further as suggested in the following paragraphs.

The teacher should explain that nearly a half-million dollars a year in defense money is now going into research on balanced systems for space capsules. Surprisingly, until several years ago no one outside of the schools worked with balanced systems which are now suddenly of national defense importance. It is too bad we do not have the combined experience of the schools recorded in the scientific publications. The teacher may use this situation to show how pure intellectual pursuits may unexpectedly lead to things of great practical importance later. Also at this point the teacher can readily emphasize the need for writing down results, keeping records, and publishing in the type of journals that libraries keep on permanent record.

There will be a tendency for students to set up fish tanks neglecting the system. Many aquarium magazines are filled with recommendations for eliminating algae and bacteria thus eliminating the most interesting aspect of the self-regulating microcosm. A fish tank is to the microcosm what the fish hatchery is to the pond. A pond runs itself; a hatchery does not.

Avoid chlorinated tapwater which often has toxic metal substances and unfavorable basic conditions.

Class 4—Dissolved Oxygen Measurements

In Class 4 a simple, inexpensive, and reliable chemical procedure for measuring dissolved oxygen is taught for use in subsequent classes. If the class is an elementary one, the procedure is done in cookbook style omitting the details of the chemistry, but if the class is at a more advanced level, some first principles of chemistry can be taught at the same time. The oxygen procedure may be carried into the field for study of outside waters too. This is a major tool of the fishery biologist and sanitary engineer.

The procedure for measuring oxygen is shown in the upper two pictures of Figure 4. The solutions are made up and added with the procedure below. Careful weighing is required only in making up the solution of the hypo although one does not need an analytical balance. In the reaction, first dissolved oxygen reacts with manganous ions to form manganic ions. When the solution is made acid, the manganic ions react with the iodide ions to form iodine. In the titration the thiosulfate

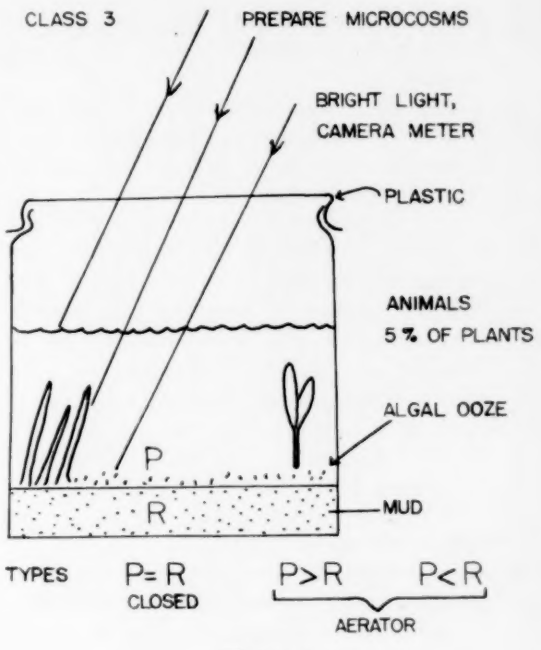

Figure 3

decomposes and changes iodine to iodide.

The Winkler Method for Measuring Oxygen in Parts Per Million Dissolved in the Water

1. Fill your oxygen sample bottle (100 to 150 cc. capacity) with water to be studied. Do it without bubbling. Siphon with a tube from a bucket dipped into the pond.
2. Add 10 drops (about 0.5 cc.) manganous sulfate solution. To make solution put 480 grams of manganous sulfate ($MnSO_4$-$4H_2O$) in 1 liter of water. This keeps indefinitely.
3. Add 10 drops (about 0.5 cc.) potassium hydroxide-potassium iodide solution. To make up solution add 500 grams sodium hydroxide or 700 grams potassium hydroxide to a liter of water. It gets hot. Then add 135 grams sodium iodide for 150 grams potassium iodide. Keep in rubber-stoppered bottle.
4. Put top on bottle and mix with three wrist motions. Keep bubbles out if possible.
5. Wait one minute in fresh water. (15 minutes in salt water).
6. Take out top and add 15 drops sulfuric acid (about 0.5 cc.). Put top in and mix with wrist motion. This is concentrated sulfuric acid obtainable from any service

station where it is used for batteries. This burns holes in clothes, metal, skin if not washed off.

7. The sample bottle should be yellow due to the formation of iodine. There is an equivalent amount of yellow iodine present for dissolved oxygen originally present. If there is no oxygen the bottle will be clear; if there is much oxygen, the bottle will be bright orange. Thus you can tell something roughly without the next step. At this point the sample or samples may be kept for a day or two. One can do this part outdoors and bring back to school for the rest.
8. With a measuring device of some sort (graduate cylinder, pipette, glass with a mark on it) measure out 100 cc. of the yellow solution.
9. Add several drops of fresh starch solution, enough to give a black or blue-black color. Starch solution can be made by boiling a tablespoon of mashed fresh potatoes in a cup of boiling water for 5 minutes and filtering through a fine cloth. It filters slowly, but one only needs a few drops. One can also use corn starch, crackers, or scraps of notebook paper in a pinch.
10. Then titrate with hypo solution. One does this by adding drop by drop hypo solution from a burette or graduated pipette until the solution changes from black through blue until clear. The number of cc. of hypo solution added is the number of parts per million dissolved in the original solution. The hypo solution is made by adding 3.102 grams sodium thiosulfate (hypo from photo shop) to a liter of water. In refrigerator this keeps for several weeks. The hypo and the starch have to be made up fresh when one starts work after a period of time.

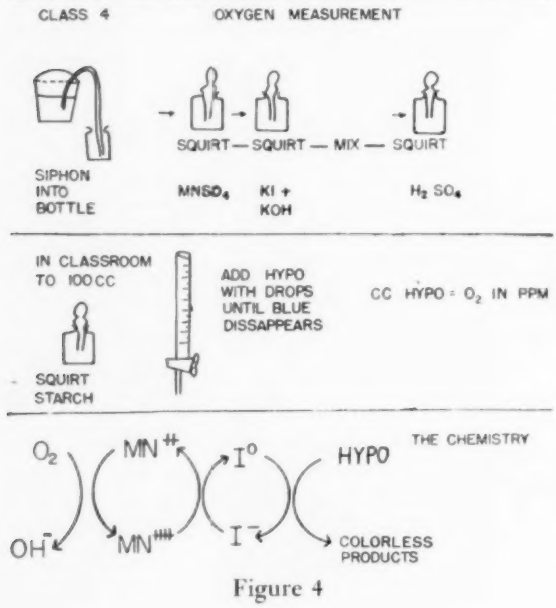

Figure 4

The reactions which take place are shown in the lower part of Figure 4. The overall result is that some yellow iodine is made in the bottle in an amount equivalent to the dissolved oxygen in the water. Then one causes the iodine color to disappear by adding a solution of hypo. If the solutions are made up as indicated above, the amount of hypo solution added indicates the amount of dissolved oxygen that was present.

The method should be tried out in some aquarium waters. Then a pan of clean water about an inch deep should be left on a table overnight. The oxygen in the water becomes adjusted to the amount which will dissolve into it from the air at the temperature. If one measures this amount of oxygen, one can state the approximate saturation value for the temperature of the room. It will be probably about 8 ppm., depending on the temperature. Exact values may be obtained from tables such as the abbreviated one that follows:

Abbreviated Table of Saturation Values for Oxygen in Parts per Million (ppm.)

	Temperature, Degrees Fahrenheit			
	32	50	75	90
Oxygen in fresh water	14.2	10.8	8.2	7.2
Oxygen in salt water, 3.5%	11.3	8.7	6.7	4.1

Class 5—Functional Relationships of Light and Plant Activity (Figure 5)

The oxygen technique learned in Class 4 is used next to measure the metabolism of plants in quart-sized containers in bright light and in the dark. Any kind of sheet of plastic may be cut to float on the water to keep oxygen from exchanging with the air very fast. Measurements of oxygen may be taken every hour and the change measured. The aquarium should be moved to a different light intensity nearer or further from the window as indicated by the light meter. Any light meter such as commonly used in photography will work. Many students have them. Then the

teacher may show the use of graphs to relate two measured quantities, light and hourly oxygen change. For successful work bright lights are needed. No artificial classroom light is likely to be over 200 foot-candles, whereas best results are obtained if values up to 1000 or more foot-candles are used. Such light comes in the window from the outdoors.

The teacher may discuss the results in terms of hypotheses predicting oxygen increase in the light and decrease in the dark. The reactions of photosynthesis may again be examined as in the first exercise.

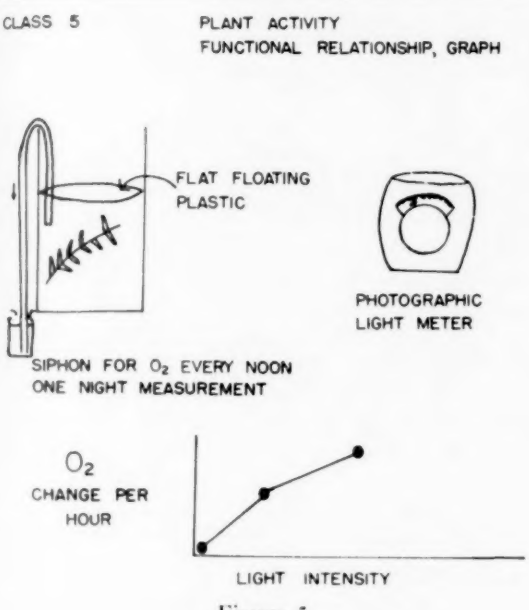

Figure 5

Class 6—Animal Metabolism and Temperature

The oxygen technique is again used, this time to study respiration of animals at different temperatures. Changes in oxygen every hour are measured with some animal such as a goldfish or crayfish in a quart of water. Graphs are plotted of the results. The role of temperature in animal respiration and the season of nature can be discussed.

Class 7—Measurement of P and R in an Ecosystem, Statistical Replication

In Class 7 the combined action of the plant photosynthesis and the respiration of animals, plants, and microorganisms in the mud is followed by making measurements in one system. The pool must be large so that many samples

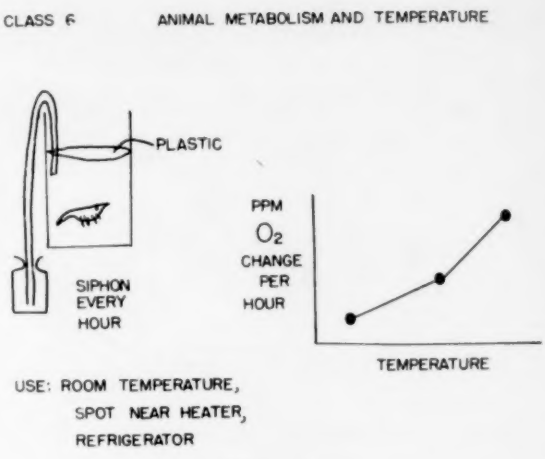

Figure 6

of water can be removed without depleting the water. One may use a fish pool, pond, tub, or big tank in the class, providing it has been fertilized, is in bright daylight, and has good green growth of algae or other plants in the water or on the walls.

In this work the idea of replication for statistical accuracy should be introduced. If the duplicate measurements taken at the same time vary less than the changes from hour to hour, then one has proof that the whole water is actually changing and that the observed values represent the water as a whole. It is desirable to mix the tub gently before sampling to improve the reproductibility.

If a curve is obtained like that in Figure 7, one may discuss what is happening at each hour. In advanced classes the amounts may be computed and compared with values in natural ecosystems (Odum and Odum, 1959).

Class 8—Controlled Experiment

In the eighth session a true scientific experiment is performed in which the teacher and class have hypotheses, but no one knows the real answer that will come from the data. Photosynthesis is measured on treated and untreated plants. The results obtained may or may not follow predictions. There may be new predictions for further experiments.

All too rarely a true experiment is not performed by a student in his education until he begins graduate work for master's or doctoral degrees. What are called experiments in most curricula are sequences of mere technique tests, measurements in which the student works to

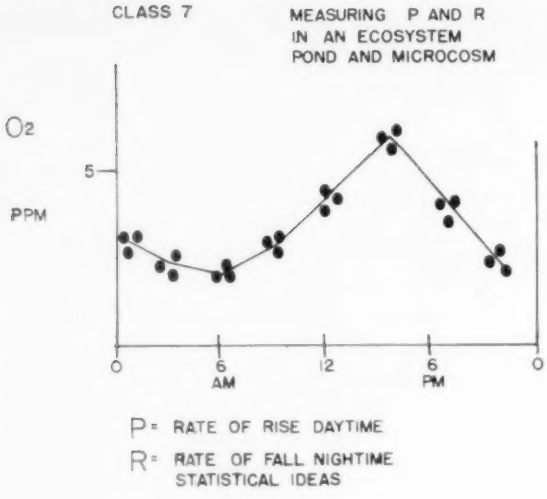

Figure 7

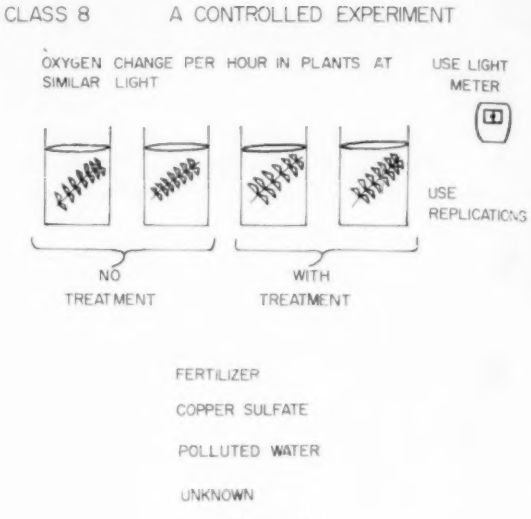

Figure 8

get a correct answer. Active science concerns instead the study of the unknown. Much in the science fairs are gadgets, devoid of adequate experimentation.

In setting up the experiment, every effort should be made to use equal sized plants, such as sprigs of *Elodea*, in equal quantities of water. Each container should be placed in similar light intensity by using the light meter. Any kind of treatment may be applied. Here is a good place for the teacher to emphasize the role of imagination in science. Students should draw ideas from their experience as to substances that ought to have some kind of effect on the plant photosynthesis. They can then test their ideas. Each set of experiments can be different.

Class 9—Geographical Aspects of Conservation

In the ninth session some of the implications of the previous measurements on ecosystems are extended with the use of scrapbook work and maps. To a large extent the distribution of fertility of nature can be related to light, the requirements for plants, or to localized accumulations of organic matter seasonally or geographically. Even the history of man's colonization and development of early civilizations may be related to the distribution of P and R on the earth. The various combinations of P and R and the various seasonal patterns of light radiation can be compared.

The teacher should include a map of the principal vegetation types of the world, a map of the rainfall zones of the world, a map of temperatures of the air and sea, and colored pictures of ecosystems. The teacher might ask which student can accumulate the most ecosystems from clipping magazine pictures. Each student may try to state something about the overall metabolism (photosynthesis and respiration). What does man do to an ecosystem when he applies such treatments as fertilization, weeding, clearing, draining, harvesting, poisoning, isolating, burning, eliminating fire, etc.?

CLASS 9 GEOGRAPHY AND CONSERVATION

BLANK MAPS OF WORLD — DRAW IN
VEGETATION ZONES, FERTILE SEA ZONE, REEFS
AGRICULTURE TYPES,

SCRAPBOOK:
CUT OUT PICTURE OF SYSTEMS AND WRITE IN
P– R STORY
P– R BALANCED
P>R PRODUCING– NEED RAW MATERIALS
P<R CONSUMING– RELEASES RAW MATERIALS

INCLUDE POLLUTION, ANIMAL HUSBANDRY, AGRICULTURE
FISHING, ARCTIC, TROPICS, WINTER, SUMMER,
SATTELLITE ECOSYSTEM

DISCUSS RAW MATERIAL STORY FOR EACH PICTURE

Figure 9

Class 10—Ecosystem Computer

One of the principal ways in which science makes progress is through the imagination of people who get an idea from one phenomenon that suggests how another situation might be

CLASS 10 ECOSYSTEM COMPUTER

USE IRON, WIRE, AND MILLIAMMETERS TO CONSTRUCT P–R SYSTEM WHERE ELECTRIC CURRENT IS THE FLOW OF CARBON

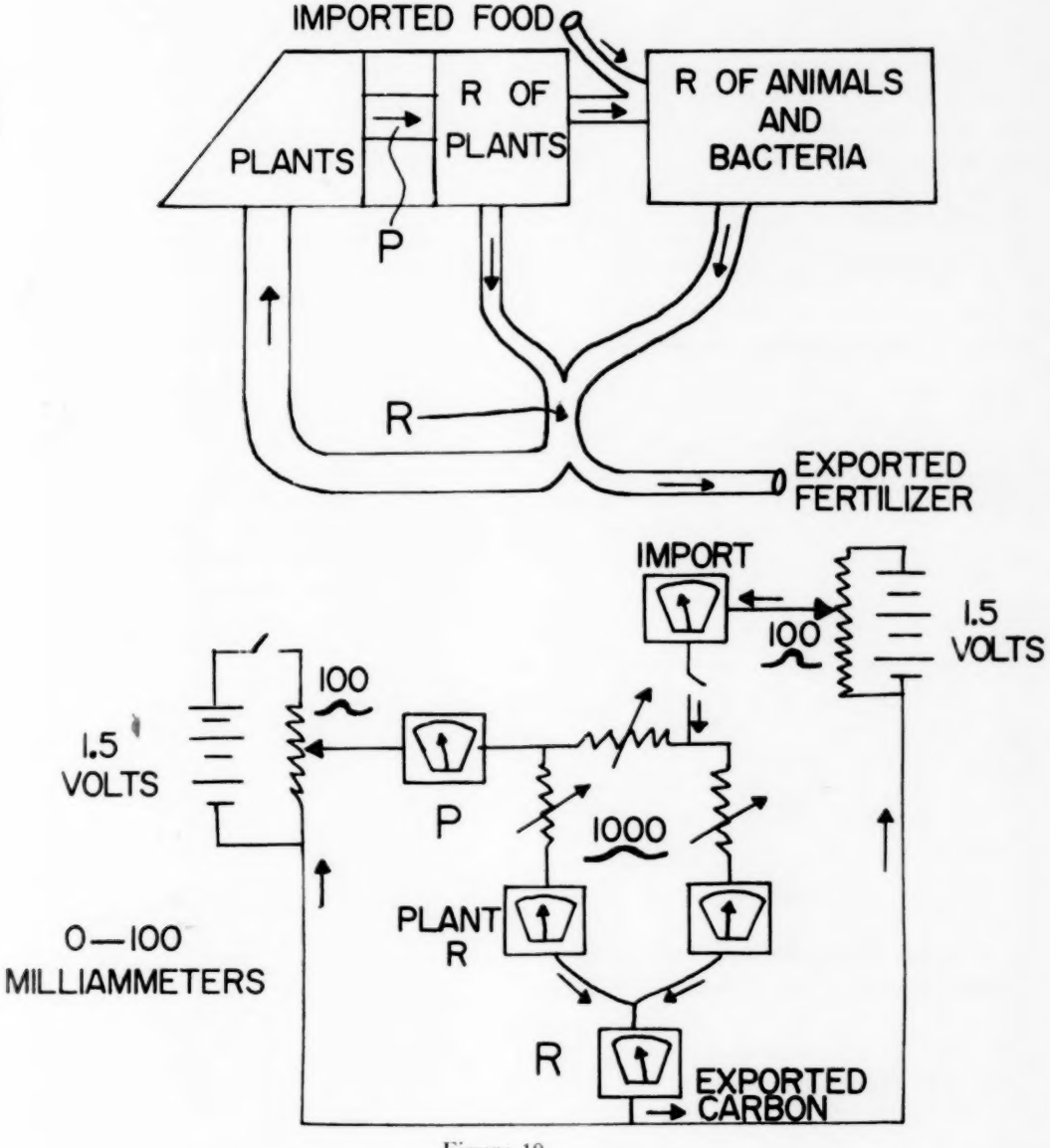

Figure 10

observed. In the tenth session we see how an electrical system can serve as an analogue suggesting things about ecosystems. Students with a yen for the soldering iron can be utilized in combining physical and biological science to make a gadget, which mimics in some ways the flow of materials in the ecosystem.

A flow diagram for materials in a simple ecosystem is pictured in Figure 10 along with an electrical analogue computer to match. The flow of electrons in the wires may be compared to the flow of carbon in the food chain and biogeochemical cycle. Batteries represent two energy sources, (a) the sun's energy for the plants, and (b) the organic matter imported from outside as in the example of the stream ecosystem when leaves fall in. By varying the resistances, one may vary the amounts of electricity in the circuits. By adjusting the circuits, one may illustrate the interactions in the ecosystem. Increasing import increases respiration; decreasing plant respiration increases the amount available to animal respiration, for example. The voltage in the electrical circuits may be compared to the concentations of food that occur in nature. An accumulation of plants in high voltage in driving food through snails, for example. The system in Figure 10 is a simple case for an ecosystem in a steady state, without seasonal or other changes. With some ingenuity, with electrical condensers and with the help of the physics classes much more elaborate arrangements are possible. Student projects may study further the ecosystem in nature, in the classroom, and in electrical analogues. Ecosystem science is new and these things have yet to be done by anybody. Thus the ten sessions on science can end with some vision of the future and the possible control of nature when the circuits of the ecosystem can be controlled.

Reference Cited

Odum, E. P. with collaboration of H. T. Odum. *Fundamentals of Ecology*. 1959. Saunders, Philadelphia.

Rockefeller Report

A splendid review of modern biology with illustrations is incorporated in the Rockefeller Foundation Annual Report of 1958. The review also includes a historical treatment of the natural sciences by Warren Weaver. It may be obtained from the Foundation, 49 W. 49th St., New York.

For Time-Lapse Photographers

A new movie-control apparatus for time-lapse photography is available from the Sample Engineering Company, 17 N. Jefferson, Danville, Illinois. They are also making available at $4.75, John Ott's book, *My Ivory Cellar*, on time-lapse photography.

A New High School Laboratory Instrument—The Ophthalmoscope

Through a grant from NSF, an instrument, new for secondary school biology laboratories, has been developed by the Midwest Research Institute, 425 Volker Boulevard, Kansas City 10, Missouri. This company is not interested in manufacturing the instrument, but it has prepared an excellent report on the instrument and its uses. This is available upon request. It opens up some new areas for student investigation as well as class use.

Airborne Television

Airborne television will receive major attention during a Conference and Workshop in Education Media to be held at Indiana University, June 27-July 1, 1960. Devoted mainly to the utilization of television for educational purposes, some time will be spent on open-circuit and closed-circuit television, and other types of instructional materials. Lectures, demonstrations, and group discussions will deal with such specific aspects of airborne educational television as (1) plans and possibilities, (2) the nature and role of the medium as an instructional resource, (3) classroom application, (4) program information, and (5) demonstrations of actual educational uses.

The Conference and Workshop are designed for principals, supervisors, classroom teachers, co-ordinators of educational media, and those leaders who have responsibility in connection with the use of audio-visual materials, including school board members, PTA members, and staff members of state departments of public instruction. The Conference will be open, at no charge, to interested participants on a conference basis without credit. Those wishing to earn an hour of graduate credit in R505 may do so by spending an additional three days, June 29-July 1, in the Workshop. L. C. Larson, Professor of Education, Indiana University, will serve as chairman of a committee in charge of the Conference and Workshop.

Biology-Fact and Future

BURTON E. VOSS
The Pennsylvania State University, University Park

From time to time it seems imperative that we examine the status of the teaching of biology. Studies by Martin[1] and Fitzpatrick[2] have contributed much. Since the Sputniks have ushered science teaching into the spotlight, facts regarding the present situation are absolutely essential. This report concerning the teaching of biology is a dissection of a study of a much broader scope. It concerned the status of science education in Iowa high schools, 1957-1958.

Procedure

The data were collected by two methods: (1) by a questionnaire returned by administrators and teachers in a random sample of 215 Iowa high schools, and (2) by a personal visitation of 185 science classes, and interviews with 132 science teachers in 60 of the high schools. For purposes of comparisons between groups of schools, the schools in the study were divided into four groups according to enrollment. The distribution of the 754 Iowa public high schools in 1957-58 according to enrollment intervals and per cent of students and schools in each interval is shown in Table 1.

The 215 schools represented approximately 28 per cent of the Iowa high schools, 1957-58, and at least 25 per cent of the schools in each enrollment interval. For purposes of follow-up of the questionnaires, 15 schools were selected at random from each enrollment interval and were visited by the author. Also the teacher certification files in the State Department of Public Instruction were used to supplement and check information.

This paper will deal with three major areas; first, the biology curriculum; second, observations of facilities and instructional methods; and third, investigation into the status of the biology teacher. It is hoped that facts will be presented and future needs may be described to improve the teaching of biology in secondary schools.

The Curriculum

A study of offerings and enrollments in biology in Iowa high schools revealed a sharp increase. In 1934, 10.6 per cent of the students in Iowa high schools were enrolled in biology; in 1958, 21.3 per cent, an increase of 10.7 per cent. The percentage of Iowa high schools offering biology increased from 45.7 per cent in 1934 to 82.2 per cent in 1958, a gain of 36.5 per cent. Further examination of the data revealed that a total of 94.83 per cent of the high schools offered biology because some schools offered biology in alternate years.

There was little evidence found to give aid to the present problem of the grade placement of biology. About 77 per cent of the schools which offered biology placed it in the tenth grade. Three per cent of the schools offered it to a combination of ninth and tenth grade students and twenty per cent of the schools offered it to combinations of tenth, eleventh and twelfth grade students. The practice of offering biology to combined grades was found in schools having less than 250 students. One school was experimenting with a group of accelerated ninth grade students who were taking tenth grade biology. The teacher said the group was doing very well. Some school administrators were considering moving the tenth grade biology into the ninth grade because they felt their students were obtaining good science backgrounds in grades K through eight. One reason given for holding biology in the tenth grade was the lack of uniformity of experiences in the lower grades, thus suggesting that a general science course is needed in the ninth grade. Most of the school systems in Iowa have a four year high school. Students enter these high schools from diverse grade schools and backgrounds; thus this may be a reason for a strong ninth grade general science program.

The content of biology has changed very little over the last 25 years. An analysis of biology texts from the period of 1930 to 1957 revealed few changes. Major changes were in the field of medicine—the antibiotics, the Salk vaccine, and atomic energy as applied to biology. The organization of the texts had changed. The large number of topics presented in 1930 had been condensed into fewer

TABLE 1
Stratification of Iowa High Schools, 1957-1958
Grades 9-12

	Student Enrollment	*Frequency*	*Per Cent of Total Schools*	*Number of Students*	*Per Cent of Total Students*
Group I	0-99	398	52.79	23,598	17.64
Group II	100-249	253	33.55	38,787	29.00
Group III	250-499	60	7.96	21,355	15.97
Group IV	500 above	43	5.70	50,031	37.40
TOTAL		754	100 per cent	133,771	100 per cent

numbers of comprehensive units. For example, a text used in 1934 had 20 units—today it has 10 units. Topics most frequently omitted by teachers were sections dealing with atomic energy, by 80 per cent of the teachers; conservation, by 20 per cent of the teachers; and evolution, by 16 per cent. Reproduction was included by most of the teachers, but very little on human reproduction.

Seventy per cent of the 59 biology teachers used the basic organization of the textbook as their course of study in biology. Few teachers utilized other courses of study to aid in their planning. Ten per cent of the teachers stated they supplemented the text with outside reference materials. Thus the textbook was really the major source of science investigation by the teachers and the students. Quote one teacher, "I just have to get away from the book, but I have to finish it."

Facilities and Instructional Methods

Check lists were devised in order to facilitate observations of facilities and instructional methods. Unannounced visits were made to 57 biology classrooms.

The most common classroom organization was a combination lecture-laboratory facility in 57 per cent of those visited; however, 30 per cent of the classrooms which were visited had no tables for laboratory or project work.

Most schools had access to audio-visual aids such as films, slides, film strips, and biology charts. Most of the smaller schools had at least one microscope; however, sometimes it was not in operating condition. Some schools had a Rayoscope or a Bioscope. In general, equipment ranged from very sparse in small schools to adequate in the large schools. However, much dusty, unusual equipment was discovered in equipment storerooms. The amount of money budgeted per student enrolled in science courses was $2.00.

Supplementary textbooks were scarce. About ten per cent of the biology classrooms had a set or sets of supplementary textbooks. Those classrooms having supplementary textbooks were found in schools having more than 250 students. Most science reference books were found in the school library. There was an average of 20 science reference books in Group I schools, 56 in Group II schools, 153 in Group III schools, and 339 in Group IV schools. Science periodicals were found in most of the schools. Those applying to biology were *Audubon Magazine*, *Field and Stream*, *Iowa Conservationist*, *Natural History*, *Nature*, *Today's Health*, *Scientific American*, and *Outdoor Life*. *The American Biology Teacher* was found in 20 per cent of the schools which were visited.

Instructional methods were observed in 57 biology classrooms. The class was observed for the entire class period. The kinds of methods observed were a question and answer recitation in 37 per cent of the classrooms, laboratory in 5.79 per cent, review for a test, 10.53 per cent, a test in 7.02 per cent and teacher demonstrations in 7.02 per cent. Directed study was observed in 5.26 per cent of the classes and non-directed study in 10.53 per cent. Other types of activities which occurred in less than 7 per cent of classes were lecture, project work, a field trip, discussion of an exercise from the workbook, grading a test, student demonstrations, teacher-pupil planning, student reports, a whole period devoted to writing answers to questions at the end of the chapter, and preparation of reports.

Procedures for laboratory instruction were quite varied. Four of the 59 teachers interviewed offered no laboratory work but relied

upon demonstrations only. Thirty-nine per cent of the teachers organized students into groups of from three to five for laboratory work. Four of the teachers had individual student laboratory work. The remainder of the teachers had students work in different combinations—sometimes individually and other times in pairs, depending upon the amount of equipment needed.

Planning for the laboratory work was quite flexible. About all of the teachers planned laboratories as needed, not according to some pre-set laboratory day. On the average, 38 per cent of the teachers provided one laboratory period per week, 29 per cent, two laboratories per week, and 17 per cent, one laboratory every two weeks. About 7 per cent of the teachers provided no laboratory work. The kinds of laboratory work observed were the following:

1. One laboratory period was observed where the teacher led the students through the dissection. He would point out the structure on his specimen and the students would find it on theirs.
2. One teacher gave students preserved organisms to observe. Then they used references to help make a report on what they had discovered.
3. One teacher had a collection of labelled specimens and the students had to learn them during the period.
4. Some classes were observed making studies and dissections following the directions in the laboratory manual. Thirty-eight per cent of the teachers used laboratory manuals.
5. A few teachers used self developed laboratory sheets which the students followed and upon which copied their laboratory results.
6. Some classes were observed copying pictures from the biology book into a laboratory notebook.

Most of the biology teachers took their classes on at least one field trip per year. A few of them did not utilize field trips for the following reasons, (1) too many students involved in a day, (2) class periods were too short, and (3) the school administration discouraged field trips.

The teachers were interviewed about problems in science teaching. These problems were individual differences, by 32.58 per cent of the teachers; lack of science equipment, by 23.48 per cent; inadequate laboratory facilities, by 21.21 per cent; and time for improving demonstrations and experiments, by 18.18 per cent. Others mentioned in order of frequency were time for helping individual students, heavy teaching load, lack of good demonstration techniques, lack of background, and sources of good projects.

Teachers stated they were attempting to meet the problem of individual differences by having students do projects, make extra reports, read scientific journals and magazines, or through the science club. Few schools, mostly those in Group IV, employed grouping.

About 35 per cent of the teachers had students do biology projects. However very few projects were observed in the biology classrooms.

Forty-seven per cent of schools had a science club. Interest activities for promotion of science were local science fairs, participation in state-wide science fairs, science clubs, participation in science scholarship exams, science assemblies, and vocational assemblies.

The Status of the Biology Teacher

Examination of the preparation of biology teachers revealed that they had an average of 24 semester hours of preparation in biological science. Of the 187 biology teachers, 11 per cent did not meet minimum Iowa State certification standards. This is 15 hours of science with at least six hours of preparation in the subject taught.

The most frequent subject taught with biology is general science. This is especially true in the small school where quite often the science teacher teaches all of the science courses. It was only in the schools having more than 500 students where specialization occurred. There about all of the teachers taught only biology. A few taught another science course such as general science, or physics, or chemistry. An examination of science background of those teachers teaching only biology revealed that 14 per cent had no preparation in chemistry or physics. There is a trend in making biology more quantitative and experimental; thus it is becoming increasingly imperative that biology teachers have

training in mathematics, chemistry, and physics.

Twenty per cent of the biology teachers belonged to the NABT.

Conclusion

The future of biology teaching is both bright and cloudy. On the cloudy side we found that much biology teaching was quite routine. The textbook was the course of study. Heavy dependence upon recitation limits the many challenging activities which can be implemented in the biology classroom. Iowa is in desperate need of school district reorganization. Teachers in the small schools face many problems. On the bright side there was a core of very fine teachers in Iowa high schools. Enrollments in biology are increasing. I am optimistic. With increased content preparation of biology teachers, with stronger efforts to professionalize biology teachers, and with a strong push to bridge the gap between what is presented in biology methods books and what is practiced in the classroom, a great deal can be done to improve biology teaching.

[1]Martin, W. E. *The Teaching of Biology in Public Schools of the United States.* U. S. Office of Education, Bulletin 1952, No. 9. Washington: Government Printing Office, 1952. 46 p.

[2]Fitzpatrick, Fred. "Trends in High School Biology." Bulletin of the National Association of Secondary School Principals. 37: 56-67; January 1953.

BIOLOGY IN THE NEWS

Brother H. Charles, F.S.C.

FASCINATION OF THE UNKNOWN, Lyn Tornabene, *Cosmopolitan*, January, 1960, pp. 28-29.

Short summaries of the accomplishments of five scientists which may inspire others to imitate their efforts.

DANGER IN YOUR DRINKING WATER, Alvin B. Toffler, *Good Housekeeping*, January, 1960, pp. 41-43, 128-130.

Is the water which comes from the faucet in your home fit to drink? Uncontrolled dumping of sewage, detergents which are not removed by our ordinary means of sewage reduction, and insecticides, weed killers, and radioactive wastes which are washed into the streams, all increase the difficulty of supplying drinkable water to most of the people in these United States. What factors make for impure water in your community?

WE PROPOSE TO DISPOSE OF THIS NUISANCE, *McCall's*, January, 1960, pp. 50-52.

Good bulletin board material to initiate profitable discussion about garbage cans and the hazards of using them.

RIDDLE OF THE FROZEN GIANTS, Ivan T. Sanderson, *Saturday Evening Post*, January 16, 1960, pp. 38, 82-83.

What killed the prehistoric mammoths and other mammals now found preserved in arctic ice? The author discusses old and new theories as to how these animals are so well preserved in deep freeze.

MYSTERIES OF THE CAVE PAINTERS, John Masters, *Saturday Evening Post*, January 2, 1960, pp. 30-31, 94-95.

Pictures and descriptions of paintings made by prehistoric man. This article tells something of the discovery of these paintings and the controversy about their validity.

WE HUNTED LIONS WITHOUT GUNS, Hodding Carter, *Saturday Evening Post*, January 9, 1960, pp. 30-31, 68-69.

How a family learned many interesting things about the animals in Africa's Kruger National Park. This is an excellent account of the fun people can have photographing animals and of how animals can be approached if the observer is in a car.

MY 15,000 RATTLESNAKES, R. P. Jacoby, *Outdoor Life*, January, 1960, pp. 40-43, 109-112.

Interesting descriptions of the habits of various kinds of rattlers by one who has made rattlesnake hunting his business.

WHY DOCTORS CHARGE SO MUCH, Richard Carter, *Redbook*, January, 1960, pp. 25-27, 93.

All of us wish good medical care at a cost we can afford. Many try to provide this care by taking out health insurance. But this insurance usually pays for less than half the costs. Why? Are the fees too high? This article should arouse much discussion.

THE TERROR OF THE TREE TOPS, Ronald N. Rood, *Coronet*, January, 1960, pp. 79-82.

A description of the fisher and its habits. This is a little known mammal, which has been saved from extinction by protective regulations of the U. S. Wildlife Service.

Bacteria Eat Too

An Approach to the Teaching of Nutrition

PAUL KAHN

Bronx High School of Science, New York

As a biology teacher, do you have difficulty finding suitable demonstrations for the unit on nutrition? Are your food experiments routine? Justification for this unhappy state of affairs is difficult in view of the extraordinary amount of current research devoted to nutrition. So important has the subject become that it has all but revolutionized the fields of genetics, microbiology, and cancer research.

But why the perplexity in the classroom? Perhaps reliance on the old standbys of rats, mice, and guinea pigs is to blame. Picture the difficulties involved: the expense of purchase of the animals, the complexities of construction of animal shelters, the obstacles toward acquisition of proper food mixtures, the labor of continuous care for the animals, the necessity for waiting long periods of time to complete experiments—to mention just a few. Now make the contrast with bacterial exercises which involve organisms to be had for the asking, everywhere in uncounted millions. Here almost no care need be applied, merely a bit of technique. And best of all, simple experiments can be devised by and for youngsters with the results often available within 24 hours.

Bacteria and Proteins

Consider a basic nutritional problem, yet one rarely recommended for classroom investigation: What nutrient is fundamentally required for growth? No doubt a limiting factor is that a single nutrient is, by itself, inadequate for proper growth of rodents or other higher animals. With bacteria, however, the cause and effect relationship of proteins to growth can be beautifully demonstrated.

Simply plug six test tubes with cotton and add ten ml. of each of the following, one nutrient per numbered tube:

1. Water
2. 1% solium chloride
3. 2% glucose
4. 2% peptone
5. Vegetable oil
6. About one ml. of vitamin suspension (prepared by dissolving one vitamin tablet in 150 ml. of water).

For precise work, sterilize the tubes in an autoclave or by boiling in a water bath for periods of one-half hour on three successive days. Inoculate with the desired organism, *Escherichia coli* being recommended; incubate at either room temperature or 37 degrees C° for from 24 to 48 hours; and observe for cloudiness or turbidity. Note the appearance of the protein tube 4 Figure 1.

Where sterilization procedures are totally impractical and where *E. coli* is unavailable, the tubes may remain unsterilized. Inoculate by removing all cotton plugs and exposing the tubes to air bacterial contamination for twenty minutes.

Since microbial growth is directly proportional to turbidity, biology students should be in a position to draw conclusions from the experiment. But beyond the obvious finding that protein alone of all the nutrients is capable of promoting growth of bacteria, the class can be led to conclude that other questions have been raised. Perhaps a few may be of overriding current importance, either to the pupil or to the modern research in the field. Among them:

1. Will a diet of candy alone be sufficient for growth of a bacterium?
2. Is there one kind of vitamin pill or a mixture of several that would be adequate for microbial growth?
3. Can a mineral mix be prepared that will promote growth of a microorganism? (Refer to the Kraus-Myer medium for growth of blue-green algae.)
4. How do different proteins (gelatin, albumin, casein) compare in their growth-promoting ability?
5. Can amino acids either individually or in combination produce bacterial growth?

The alert class should be anxious to pursue the problems they have identified. The alert teacher should provide the opportunities to investigate these problems, either individually or in groups, at home or in school, as laboratory exercises, or as projects.

Bacteria and Carbohydrates

Consider a second nutritional problem for cooperative solution by a biology class; namely, what effect will a combination of two nutrients have upon bacterial growth? After discussion of the possible combinations, the class may decide on the following experimental design:

1. Minerals and carbohydrates
2. Minerals and proteins
3. Minerals and vitamins
4. Carbohydrates and proteins
5. Carbohydrates and vitamins
6. Proteins and vitamins

Water combinations have been purposely omitted because, as a solvent, it is necessarily present in all mixtures. And since oil is immiscible in water and does not dissolve most of the other nutrients, it, too, has been eliminated.

The findings, interpretations, and conclusions should be developed with the class. However, Figure 2 demonstrates with some clarity the increase in growth of a microorganism in a protein-carbohydrate mixture when compared with a protein control. The energy obtained from the carbohydrate is shown to be a major growth factor.

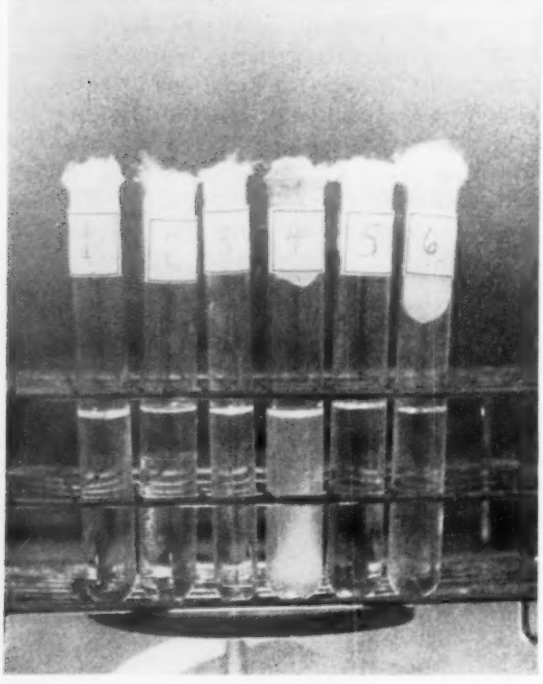

Figure 1. Comparison of growth-promoting abilities of six nutrients.

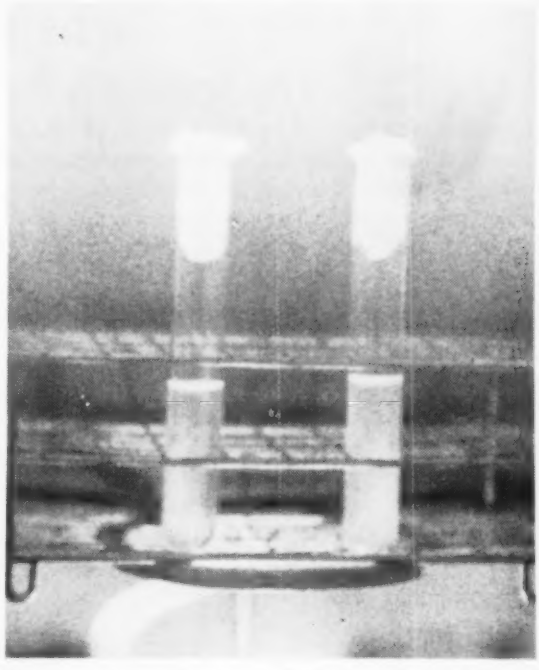

Figure 2. Comparison of protein with protein and glucose.

Related problems the class may find suitable for investigation include:

1. What is the optimum concentration of glucose for maximum growth of a microorganism?
2. How much glucose is required to harvest a crop of 1 gm. dry weight of a bacterium?
3. What is the minimum concentration of glucose that will inhibit the growth of a microbe?
4. Build a calorimeter and compare the calorie content of pure protein, fat, and carbohydrate.
5. How does the calorie requirement of humans compare with that of a microorganism per unit of weight?

Bacteria and Other Nutrients

Consider a third nutritional problem: Will combinations of three nutrients increase bacterial growth still further? Under the foregoing conditions (elimination of water and oil mixtures) four combinations are possible:

1. Minerals, carbohydrates, proteins
2. Minerals, carbohydrates, vitamins
3. Minerals, proteins, vitamins
4. Carbohydrates, proteins, vitamins.

All but the second combination should produce increased growth over the best obtained in the previous problem.

The following comprise possible problems for collateral investigation:

1. What is the optimum concentration of the third nutrient added?

2. Determine a curve of concentration for a limiting mineral, such as a phosphate.
3. Does *Rhizobium leguminosarum* fix nitrogen?
4. Make a microbiological assay of a growth factor using a species of *Lactobacillus.*
5. Will large amount of vitamins inhibit microbial growth?
6. Compare various vitamins in growth promoting ability.

Unit on Nutrition

At first glance it may appear that the experiments are uneconomical of time and effort. But the remarkable quality they possess is that they can be combined into a single almost all-embracing demonstration. And the entire effort from inception to completion can be accomplished within a three-day period. It is urged that the remainder of the time set aside for the unit on nutrition be devoted to "biology-by-doing" using a research-seminar approach. For many reasons the biology teacher may prefer other pedagogical methods which can be readily applied. In any case, the following represents a three-period, day-by-day breakdown of the nutrition unit as developed and introduced by the author during the past year.

First Day: Launching the Unit. (Slower classes may require two days.)

A. How are modern scientists learning about nutrients?
   1. Discuss early food experiments to find out what was learned and how they were performed.
   2. Elicit the difficulties such workers as Goldberger and Eijkmann may have had.
   3. Introduce the microorganism as the organism of choice in many laboratories and determine its advantages.
   4. Discuss turbidity as a measure of microbial growth and demonstrate the colorimeter, if available.
   5. With the class, work out an experimental design for a single experiment embodying three problems discussed above. Figure 3 illustrates one exercise of this kind.
   6. Using prepared solutions of the nutrients, have student helpers pipette the materials into the test tubes following the experimental design.
   7. After class, arrange for a student committee to sterilize the media.

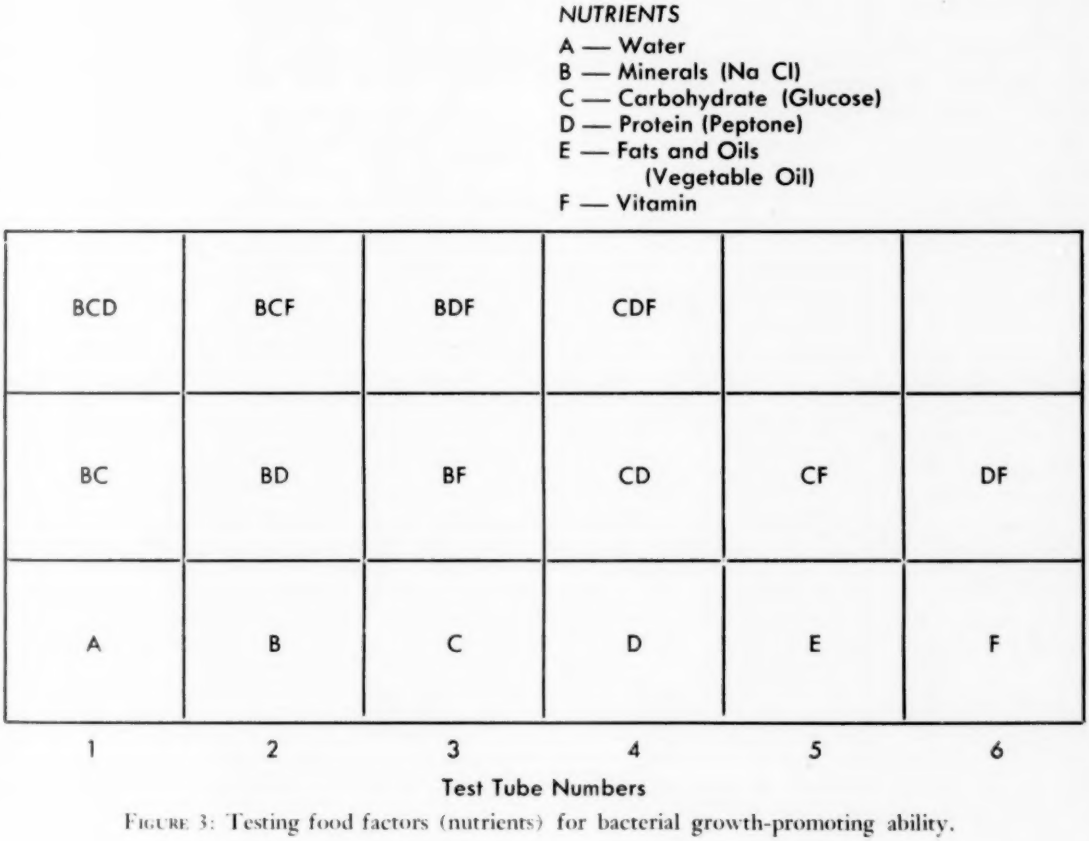

FIGURE 3: Testing food factors (nutrients) for bacterial growth-promoting ability.

Second Day: Inoculation of Media.

B. How is a good experiment set up and performed?
   1. Have pupil assistants inoculate all test tubes with equal quantities of *E. coli* (about 0.2 ml of 24 hour suspension would suffice).
   2. Show film entitled *Vitamin B1* and discuss the excellent sequences illustrating the experimental procedures with pigeons and rats.
   3. Elicit the shortcomings of the specific methods shown in the film, for example, the use of very few animals and the deficiency of a reciprocal experiment.
   4. Determine the advantages of the techniques used by the class over that given in the film.

Third Day: Observations and Conclusions.

C. What conclusions can be drawn from the experiment?
   1. Visually or with a colorimeter record results of the experiment.
   2. Draw tentative conclusions and discuss the reasons for their temporary nature.
   3. List problems for further investigation.
   4. Assign problems either on a voluntary or required basis.

When faced with such vexing problems as lack of time, materials and laboratory space, the biology teacher may well be forced to conclude the unit by means of book assignments, recitations, and the like. In that event, the problems should be assigned on a voluntary basis for completion either at home or at odd moments during and after the school day with whatever aid can be mustered. From time to time the volunteers should be called upon for progress reports in class and to submit final written "papers."

By far the better procedure is to have the problems assigned to all students, individually, or in groups. Investigations should be carried on immediately, on class time, and in the school laboratory. In addition, concurrently by all, intensive and extensive library research should be undertaken on the problems under investigation as well as on the unit as a whole. When most of the results are in, a series of seminar discussions should be held to tie together the outcomes developed by the unit.

To summarize—this article approaches the teaching of nutrition from two directions: from that of content and from that of method. For the first, it offers a unit on microbial nutrition complete with laboratory techniques, problems and projects. For the second, it advocates a research-seminar teaching procedure. Both proposals are believed to be novel.

Tranquilizers

Some tranquilizers exert their effects by working in tiny "chemical factories" within the body cells. It is in these tiny "factories," called mitochondria, that chemical processes which produce energy occur, explains Dr. Leo G. Abood of the University of Illinois College of Medicine. A number of agents, including phenothiazine tranquilizers, barbiturates and some essential hormones, interfere with this energy-making process, known as phosphorylation, he observed.

The mode of action of these drugs is a highly intricate problem which is not well understood at present, said Dr. Abood, who is associate professor and director of the research laboratories in the University's Department of Psychiatry. Dr. Abood said, "It can inhibit some vital enzyme (an agent that controls certain chemical processes in the body), either by direct chemical interaction, or by interaction with some essential substance. It can interfere with the delicate balance of enzymes or structural elements within a system. It can bring about a change in the ability of essential materials to pass through membrane walls."

Some agents also function by interfering with the normal functioning of nerves at the nerve endings where a stimulus is received or where the nerve is supposed to induce muscle action, he added.

Mental Drugs

Research with the brain cells of a rat has helped explain how mental drugs influence the chemistry of the brain. A tranquilizer, a "psychic energizer" and an hallucinogenic drug had strikingly different effects on a key chemical reaction that normally ocurs in brain cells, said Dr. Donald A. Rappoport, a biochemist at the Baylor University College of Medicine. To study how these drugs affected the formation of a substance called Coenzyme--I in the brain, the nuclei (cell cores) and other rat brain cell constituents, known as mitochondria, were used. Coenzyme-I, an important body chemical regulator, is formed in the body from the essential vitamin niacin, he explained.

Honor Biology*

NAOMI M. SNYDER
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Honor biology was established in the Parma Senior High School in the fall of 1958. While we were able to find a lot of justification for such a course before we started, it was not until after the course began to unfold that much of what we had read became reality. According to James B. Conant in "The American High School Today," the three main functions of a comprehensive high school are to:

"1. provide general education for all future citizens,
2. provide good elective programs for those who wish to use their acquired skills immediately on graduation,
3. provide satisfactory programs for those whose vocations will depend on their subsequent education in a college or university."

It is with the special arrangements for the academically talented student I'd like to deal. Recommendation 4 in the Conant report states:

> "In the required subjects and those elected by students with a wide range of ability, the students should be grouped according to ability, subject by subject. For example, in English, American history, ninth grade algebra, biology, and physical science, there should be at least three types of classes—one for the more able in the subject, another for the large group whose ability is about average, and another for the very slow readers who should be handled by special teachers. The middle group might be divided into two or three sections according to the students' abilities in the subject in question. This type of grouping is not to be confused with across-the-board grouping according to which a given student is placed in a particular section in all courses. Under the scheme here recommended, for example, a student may be in the top section in English but the middle section in history or ninth-grade algebra."

While it is important for a high school to have a winning football team, debate team, band, or orchestra, it is also important to have winning goals for its scholars. It is true that all people are not equally endowed with physical and mental abilities. But, as teachers, we are duty bound to develop each student to the greatest of his abilities. How do you accomplish this in a classroom of 36 students with abilities ranging from low average to very superior? Frequently the bright child resents being called "square" and never allows his abilities to develop. The child or adult that dared to be different was a curiosity or peculiar. This isn't a new or modern idea. It has been a part of every cycle in the rise and fall of a culture. At the very beginning of the cycle, people will dare to be different and defy the mores, consequently breaking with the set pattern. As the culture ages, the undesirable traits begin to filter in and to be accepted until finally they become intolerable or some crisis sets in to make the people evaluate. Absolute conformity is always a sign of decline. We do not want to think of our civilization as in a state of decline. Not every person can be a leader but some must be. Surely in a democracy such as ours it is necessary to have intelligent and capable leaders—leaders that have the needs of the masses as their goals.

No one would deny that we are living in an age of science. We are on the brink of cold wars, hot wars, and the space age. To many this is harassing confusion; but from the students sitting before us, right now, must come the leaders that will form the destiny of our country. Don't you agree that these leaders need more than an average education? Don't you agree they need to know the most about all sorts of things? Even though I am a scientist, or would like to think I am, I am fully aware of the fact that mere knowledge of science and mathematics is cold and calculating—a dangerous risk. It is most necessary to educate the entire child to the fullest of all his abilities. He must learn to express himself clearly and with the greatest accuracy. He must have an education that helps him to understand why he acts and thinks as he does.

Parents have always wanted things better for their children than they were for themselves. It is evidenced by the way taxpayers

*Presented to the Ohio Academy of Science, April, 1959.

pass levies, time after time, for new schools and school improvements. But if the schools are to continue in the good graces of the parents they must prove that they are capable of educating all children—including the most gifted—the potential scholars and leaders of tomorrow—not just a group of politicians. Good manners and courtesy are necessary to the proper functioning of society but *Yes-men* are expendable—very expendable.

So far I have tried to explain why we need classes for the academically talented or gifted child. From this point on, I'd like to explain the need for honor classes in biology. The curiosity of the talented student is insatiable. Each answer only leads to another question. They aren't hard to inspire unless their enthusiasm has been dampened. In a school the size of ours (3200 students) separate classes are warranted. We can give them a broader and more thorough understanding of the subject in the honor classes because we don't have to be concerned about the student with the slower capacity for learning. In honor biology, we have 81 students out of a total of 590 students taking biology.

Identification

After we decided to adventure on this program for the enrichment of the academically talented students, the first problem we had to face was how they were to be identified. This is where the abilities of an excellent guidance department were enlisted. For the first year, we used I.Q. scores—two or three were available, achievement record in general and teacher recommendations. There are two additional means of identification I have recommended be used next year. They are reading skill scores and a scientific aptitude score. Some of the students selected weren't able to keep up with the group and others didn't desire to. These were moved into regular sections as the situation warranted. At no time were the students required to remain in honor biology. The situation was kept very fluid. During the course of the first four marking periods, eight persons were moved out of the honor sections and seven were moved in. Whenever a move was warranted, the teacher conferred with all persons concerned—this included the student, his parents, his counselor, and the other teacher. Most of the changes were made the first and second marking periods. The parents and students were always advised that it was the best interests of the student that prompted whatever changes were made. Of the seven that were moved into the honor sections, every one has been able to keep up his good work. They report they feel more challenged than before because now they realize there are others that aren't afraid to think for themselves. There was some concern at first as to whether or not these youngsters, chosen to participate in such a course, might develop conceit or "big heads." Several students warranted my attention being called to this quality. As the year progresses, I am happy to announce, quite the opposite is true. They all have their ups and downs. The same one is not always on top nor is the same one always on the bottom. When the latter situation does occur, it is time for conference.

For the students participating in honor biology, this is an opportunity that entails a responsibility, not a glory to wallow in. These are serious students, all of which intend to continue their education beyond high school.

According to Dr. Paul Brandwein, there are three determining factors which identify a gifted child. They are—the genetic factor, that is the abilities with which the child is born—the predisposing factor, the ability to be an individualist, to dream and yet to recognize reality—the third is the teacher who makes giftedness flourish. How often, in history, has the student excelled the teacher? It takes just the right amount of encouragement at the right time to start the little genius on his way.

Enrichment

This brings me up to the third point, the enrichment program. How do you teach the academically talented student? I'm sure I don't have all the answers. As time goes on, I can see a great many ways that my existing program ought to be changed. One of the first points is the selection of a good textbook. Although I am not one to rely on or adhere to a textbook, it is a convenient source book for basic information and I do feel that basic information—including definite definitions—is very necessary to make sure that we all understand each other. At this point, I'd also like to mention that a good reference library in the classroom is also necessary. With stu-

dents of this caliber, you can never be certain what turn the day's lesson may take. A delay in investigating always lessens the enthusiasm or it may be conveniently forgotten; however, when a specific answer cannot be looked up quickly, this presents another opportunity for enrichment—the oral report. This report must be based on at least two sources, one of which may be an encyclopedia. Each student is required to make at least one such report during the course of the year; the object of the oral report being to enable the student to talk freely before his equals and answer their questions. He is expected to become the authority. Another opportunity for students to share knowledge is afforded by the book report. This may be written or oral, as preferred. The student is expected to discover if the author is an authority in the field in which he has written. This helps the student to evaluate the book by the scientific method. It is surprising how critically the books are read and then, when the opportunity presents itself in class, the students compare various books and their authors.

In the fall of the year, when specimens are readily available, is always an ideal time to do collecting. At this time, it still may be rather hit or miss but the class is usually very successful at developing order out of apparent chaos. From their previous study of general science, they have some idea of classification. Here is the ideal opportunity to teach classification thoroughly and the need for scientific names which are uniform. Preservation of specimens and preparation of cultures of algae and protozoa should be started at this time. There is nothing more inspiring than to hear a student say, "I never saw so many things before you made me look for them." Of course, there are certain things they need to be told to look for; such as, a walking stick, a dead leaf butterfly, the grub of a Japanese beetle, a hydra, a planaria, or a fresh water sponge. Collections can be made any time of year but this is the way most students like to start.

All of us are aware of how fast science is changing and to these young people it is interesting to keep up with science events through newspapers; magazines, such as *Science Digest*—which we use in class, *Scientific American*, *National Geographic*, *Natural History* and the *Ohio Conservation Bulletin*. As a requirement, they are expected to bring in 24 such articles.

The real opportunity for enrichment comes with the preparation of a research project. They may choose any problem they wish, and they are expected to pursue it more thoroughly than it has been or will be studied in class. This year I required these projects to be prepared in time for the local Science Day. After this was over and many of them could see how to improve their projects, opportunity was given to them to enter these projects in subsequent Science Days. Others of them are starting new projects for next year. Still others are going to dabble around with one thing and another until they find their real interest.

The last part of the enrichment program is to give the students an opportunity to investigate genetics or evolution. They may do a genealogy, a polyhybrid cross, a geological time table, or a problem on anthropology.

As you have noticed by this time, I have listed six requirements: 1) oral report, 2) book report, 3) collecting specimens, 4) collecting clippings and news articles, 5) a research project, and 6) a problem on genetics or evolution. The last one mentioned must be done the last six weeks because of the continuity of the subject matter. The other five may be done in any order the student may prefer to do them. It is most satisfactory not to have all the students fulfill the same requirement in the same marking period. With the aid of my laboratory assistants, I have been able to keep the requirement card for each student up to date.

There is always the eager learner who pops up with the question of what can I do for extra credit? There is a ready made answer for such a student, "You must complete each of the six requirements at least once. There is nothing that says you can't do any one more than once." Even as adults we find it difficult to complete tasks that aren't urgent or necessary. If it is required, you can always find time or make time to do it and once it is started it ceases to be a chore and becomes a pleasure.

Grading

Grading and standardizing is one of the most touchy problems of the whole program. If these are the select students to begin with,

then surely the curve is not the satisfactory method of grading. Here is where you as a teacher must be an expert salesman. You must convince the student, the parents and the administration that your system of grading is fair. I have found it most convenient to explain my system of grading to the students the first week of school and then insist that they tabulate all their grades as the papers are returned. By this method, they always know exactly where they stand. The task of determining test scores is still a problem. Here is where I have found it convenient to use standardized tests on occasion. Also, my backlog of experience has been most helpful in determining a fair grade on a given test. This is the first year I've had classes of academically talented students, and I can compare their results with the results of the average classes of the past.

Another factor I feel would be most helpful at this point is a planned course of study. It is frequently difficult to decide—shall I give them quantity or quality in my teaching. Personally, I am of the opinion that, at the high school level, we are still endeavoring to survey a course because the students' interests are scattered and many. In honor biology it is still our purpose to survey the course but, because of the abilities of the students, we are able to give it more quality. In these classes, we give the students an opportunity to do more investigating in the laboratory. We do more experiments, more dissections of a comparative nature. Learning by actual experience is still the most successful teaching method.

Special Events

These are the students that are eager for extra opportunities to learn. They will take advantage of the opportunity to participate in Science Days, Chemical Society meetings and Nature Study classes on Saturday morning or Sunday afternoon and the Science Talent Search.

Outcomes

What are the outcomes or goals for such a group?

1. To help them develop the scientific method as *their* way of thinking and doing things.
2. To help them understand the need for accuracy. This must include the art of expression and spelling. They must learn to be specific and say only what they mean to say; nothing more, nothing less. They are going to be the leaders and will give the directions. When any one of them is the surgeon and I am the patient, I'll expect him to know exactly where he is cutting, not approximately. The engineer must know all the physical laws involved in building a bridge so it doesn't collapse when it's put to use.
3. To develop an unquenchable curiosity. All the problems haven't been solved—far from it. We constantly need to point out to these people some of the problems that need to be solved and then develop within them the attitude—if he can do it, I can do it. After a recent trip to a research laboratory, one of my boys said to me "I don't think I could ever be that smart." The answer I gave was, "As long as you feel inferior, you'll be inferior. Maybe you can't do what he's doing as well as he can but there is something you'll be able to do just as well as he's doing his job, if you really want to do it." It is most important for us to develop the power of positive thinking in these young people.
4. To help them realize that quantity and quality education are both very important. When either one is lacking, the students are being short changed.
5. To develop within the student reliability and responsibility. When they become the scientists of the future, can they carry through?
6. To help them understand that leaders must dare to be individualists. New ideas and original thinkers are necessary to progress. Decline is brought about by a lack of leadership.

In summary, I have tried to explain that honor biology is necessary. There are satisfactory means of identifying talented students. I have endeavored to explain the program for enrichment that we are using at Parma Senior High School; how we go about grading and setting up standards. There are many extra-curricular activities these people are eager to participate in. And, last of all, I listed six goals or outcomes for honor biology.

Remember, there are three factors that determine what a student's future will be. They are the genetic factor, the predisposing factor and the teacher. All three are necessary to develop any student to his greatest potential. The challenge is great. Are you doing your part?

Osmosis Et Al.

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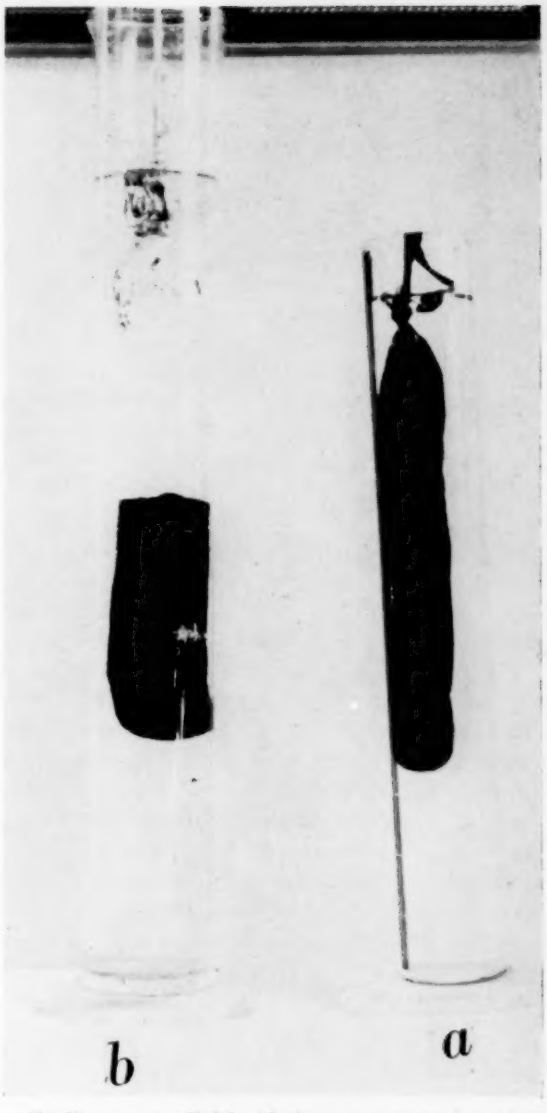
The old-fashioned osmometer, usually a thistle tube filled with molasses, covered by a membrane, and up-ended in water, belied its name scientifically in that it demonstrated osmotic rise of a denser solution, but, measured nothing. The use of iodine to demonstrate the deposition of starch in Elodea chloroplasts after prolonged exposure to light achieved its purpose, perhaps, but left a lot of other interesting possibilities untouched.

Involved in these two "old hat" experiments are basic facts at least of diffusion, solutions, concentrations, colloidal states, emulsions, dialysis, osmosis, and plasmolysis. All of them need explanation, demonstration, and understanding if we are going to do right by our students. The experiment which is described here in detail involves a number of these biophysical or biochemical life reactions.

A large test tube, preferably one inch in diameter, is meticulously cleaned in standard potassium dichromate sulfuric acid solution common in most laboratories. It is rinsed and thoroughly dried. An ether solution of collodion is next deposited over the inside of the tube by slow and careful rotation until the collodion begins to set. A second, or even a third, layer of collodion may be similarly deposited. When the collodion layers are firm, a sharp knife is inserted under the film at the lip of the test tube, and it is worked around until the collodion film is loosened all the way. A thin stream of tap water is next allowed to slowly run down between the collodion sac and the glass. This should loosen the sac so that it can be slipped out of the tube. It should be filled with water to test for any holes that would allow the contents to run out. We find that it helps to keep the collodion sacs pliable if they are stored under water until the time comes for filling.



A fairly thick solution of boiled starch is prepared. Just how dense one wants it to be depends on circumstances. We use arrowroot starch available in most supply houses. Aside from its easy digestibility in enzyme reactions, it has the advantage of turning deep black when treated with iodine.

When the starch solution is cold it is run into the collodion sac until it is about three-fourths full. The top of the sac is then tied up as tightly as possible without cutting through the collodion. A generous length of string to suspend the sac with should be provided. Unless one is abnormally deft in han-

c

dling this procedure, it will probably be good to rinse off the outside of the filled sac so that no excess of starch is left outside to complicate the experiment.

A 1,000 ml. clear graduate cylinder is used in which to suspend the filled sac. Into the cylinder is next poured enough of a straw-colored solution of iodine-potassium iodide to bring the level about equal to that of the starch in the sac.

Before the end of the average two-hour laboratory session the starch in the sac should begin to show the expected iodine reaction. Within 24 hours the coloration should be complete.

The illustrations suggest a further step which may help to demonstrate *in vitro* what has been or will be demonstrated *in vivo* when Elodea leaves are immersed in concentrated salt or sugar solutions. In order to accomplish this, a supersaturated solution of common table salt is made hot, and filtered to clarify it. The utterly blackened starch filled sac is next suspended in this concentrated salt solution. (Illustrated in *a.*)

After a few days the collodion sac will appear to have shrunk. If the experiment is allowed to stand a few days longer, the contents of the starch will become dehydrated and clump together as shown in *b.* and *c.*

Among the common plant processes which are demonstrated here, the following might be suggested:

The movement of water into plant cells.

The movement of soluble inorganic salts into plant cells.

The irritating effect of strong salt solutions on plant cells.

New Forestry Pamphlet

A well-illustrated and informative booklet, "Busy Acres In Florida," about southern tree-farms is available from the Florida Forest Industries Committee, Box 1710, Pensacola, Florida.

Filmstrips

To help audio-visual directors and classroom teachers who wish to avail themselves of the assistance offered by the National Defense Education Act, the Jam Handy Organization has prepared a listing of 392 filmstrips that are eligible for purchase under the provisions of the Act. The filmstrips listed are in four NDEA categories—Title III, Science and Mathematics; Title V, Guidance, and Title VIII, Vocational Education. The listing may be obtained free of charge by writing to the School Service Department of Jam Handy, 2821 East Grand Boulevard, Detroit 11, Michigan.

Drivers under 25 years of age were involved in 27 per cent of the fatal accidents in 1958.

Automobile bicycle collisions during 1958 injured 59,300 persons.

Certification of High School Biology Teachers

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In the spring of 1957 the Cooperative Committee on the Teaching of Science and Mathematics of the American Association for the Advancement of Science approved the organization of a subcommittee to prepare a report that would list the ideal organization of courses that should be necessary for the certification of high school teachers. All major science teacher societies were represented on the committee with the National Association of Biology Teachers assuming responsibility for formulating the requirements for biology teachers. After prolonged correspondence and discussions among numerous members of NABT, a tentative set of recommendations were presented at the 1957 meeting of the Board of Directors of NABT. Further modifications were suggested at that time and final approval was given at the 1958 annual meeting. Meanwhile, the teaching societies in the other scientific disciplines had been undertaking a similar study. When the various reports were correlated at the spring meeting of the Cooperative Committee in 1959, immediate publication of the report was urged in order that all members of societies represented on the Cooperative Committee would have an opportunity to examine the report and suggest any modifications that seemed in order. The complete report was published in *School Science and Mathematics* (April, 1959; pp. 281-289) under the title "Recommendations for the Preparation of High School Teachers of Science and Mathematics—1959." The sections of pertinent interest to biology teachers were published in the ABT (November, 1959; pages 308-312).

Publication of the report initiated a tremendous response on the part of the accrediting agencies, educational groups, and teacher training institutions. In general, the comments were overwhelmingly in favor of the proposed certification requirements. However, at the October, 1959, meeting of the Cooperative Committee it was felt that the representations made by several teaching societies concerning changes in the original report were of sufficient import to demand a revision of the initial report. Again, publication of this revision was urged as soon as possible. The committee realizes that such a report can never be considered "final" since continual changes in curriculum development, scientific improvements, and educational outlooks are constantly changing. However, as presented here, the biology section of the report has received the approval of the Cooperative Committee for immediate publication.

It is the ambition of the committee to have the standards described here adopted by accrediting agencies and used as a guide for selecting teachers. Also, this statement should be of value to colleagues in the subject matter area who are preparing teachers.

In formulating a set of recommendations for the training of high school teachers of science we are immediately confronted with several conflicting circumstances.

First. Most science teachers are required to teach several sciences including, perhaps, a course in general science, rather than just one science. This means that a teacher must have a depth of penetration in a variety of areas.

Second. Because of the impact of science in other areas, the science teacher should have preparation in the social sciences and humanities to help give him the kind of perspective that is desired in the top-rate scholar and citizen.

Third. There are certain elements in professional education which should be helpful in giving the best performances in the classroom. These elements may be provided by courses in such areas as psychology, philosophy and methodology of education, and especially by experience in student teaching.

Our problem then, is (1) to recognize, in a very objective manner, the role of these several new developments in the last decade, (2) to recognize the problems that we face in building a realistic academic program for preparation of science teachers and (3) to make recommendations with reference to the

best type of program that can be achieved to meet these changing needs.

The academic program to meet these three facets of our problem will certainly be a full one. However, assuming a minimum of 120 semester hours of academic work for graduation, these requirements may be met and still leave approximately one half of the student's academic program free for the humanities, social sciences, and professional educational courses. Many students can or will have more than 120 teaching hours of academic credit. One half of the student's time for preparation in his teaching area seems reasonable to expect if he is to be properly prepared. Furthermore, this amount of concentration can give him such depth that it will be possible for him to build on it later with a fifth year or more of content material to further improve his competence in the science area.

In all this planning to build a program to train science teachers it seems almost impossible to plan a satisfactory four-year program to prepare teachers to teach in widely divergent fields; for example, English teachers to teach physics, or social science teachers to teach biology, or physical education teachers to teach mathematics. On the other hand, if multiple teaching assignments are necessary, some favorable combinations are physics and mathematics, chemistry and physics, and biology and health.

Recommendation for biology teachers. The courses which are recommended for biology teachers, together with supporting courses, are outlined below. Each course is designated in terms of semester hours of credit; this designation is intended only to indicate the general proportion of time and the minimum requirements. The supporting courses which are recommended should be the basic courses in that science area, and not the survey courses, and should in each case include laboratory work. The description of each course which follows Table 1 is merely suggestive or illustrative of the possible topics and makes no attempt to suggest all that could or should be included.

Table 1. Suggested Courses in Biology and Other Sciences for the Preparation of High School Teachers of Biology.

(Given in semester hours.)

Suggested Courses	A	B	C	D	E	4-year total	5th year	5-year total
Biology	8	10	4	5	4	31	14	45
Chemistry						10	6	16
Physics						8	4	12
Related Sciences						6		6
Mathematics						6	4	10
Totals						61	28	89

Notes on Table 1:

1. *Description of Biology Courses*
   - A. *Principles of Biology*. Characteristics of living organisms, cell theory, structural system of plants and animals, metabolism, maintenance of individual, health and disease.
   - B. *Plant and Animal Physiology, Anatomy and Morphology*. Comparative study of functional processes of cells and tissues, structure, and behavior among the major groups of plants and animals, including the microorganisms.
   - C. *Ecology and Conservation*. Environment, soil populations, relationships of species, distribution of communities. Field work should be an integral part of this course.
   - D. *Developmental Anatomy and Genetics*. Growth and development, principles of heredity, evolution.

Cholesterol

Does cholesterol—the fatty substance believed by many researchers to cause hardening of the arteries—also offer a key to the origin of cancer? For the first time, it has been shown that a derivative of cholesterol can cause cancer in mice, reported Dr. Fritz Bischoff. Cholesterol itself is normally present in human blood and nervous tissue and also is found in animals and plants.

"Ever since it was established that the cancer-producing compounds found in some tars were related chemically to cholesterol . . . speculation has been rife as to whether or not cholesterol could be or might be the forerunner of cancer-producing compounds. Theoretically, transformations of cholesterol to cancer-producing compounds might take place outside the body in such processes as cooking —particularly over-cooking—or inside the body, by some devious metabolic route."

E. *Preparation and Use of Biological Materials.* This course should be conducted by one well conversant with the problems of biology teachers. Consideration should be given to problems of microtechnique, cell and tissue culture, field collections, and preparation and care of small organisms.

2. *Fifth Year*

There should be a minimum of mandated semester hours in biology to permit more flexible selection of courses which will be of most benefit to the teacher. "Cultural" courses in general science should be permitted, such as: history of science, problems of atomic age, laboratory techniques in more than one science, *et al.* 25 per cent of the year should be devoted to definitely biological topics, such as radiation biology and taxonomy. It is to be understood that more courses in biological sciences should be encouraged as electives.

3. *Description of Courses in Other Sciences.* Principles of inorganic and organic chemistry, particularly as it applies to living things. Laboratory work should be included. Biochemistry is recommended in the fifth year. The related sciences should contain, not only the elements of geology but also some topics relating to meteorology, physical geology, and astronomy. Standard courses in physics and mathematics are expected. In the latter field, statistics is recommended in the fifth year.

Book Reviews

THE FEMALE OFFENDER, Caesar Lombroso, 313 pp., $4.75, Philosophical Library, New York, 1958.

This study in criminal biology, which grew out of the author's collaboration with William Ferrero (although almost a hundred years ago) should be particularly welcome to counterbalance the mainly analytical and psychologically dynamic hypotheses of today. Lombroso pleaded emphatically for differentiation between the casual offender and the habitual as well as hereditary, pathological criminal.

THE PRESERVATION OF YOUTH, Moses Maimonides, 92 pp., $2.75, Philosophical Library, New York, 1958.

Composed in the twelfth century for the personal use of the Sultan Saladin's son, this is an astonishingly modern work, by one of the great practicing physicians of all time. Drawing upon the best classical and medieval principles of healing, corrected by his own vast experience, Maimonides prescribes a complete therapy of mind and body, including recommendations on diet and exercise, sex life, and hints on the psychological causes of illness.

THE FIRST AUSTRALIANS, Ronald M. Berndt and Catherine H. Berndt, 144 pp., $4.75, Philosophical Library, New York, 1954.

Here we see the aborigines first against our own environment. Then the rich diversity of their life throughout the continent is gradually unfolded, like a colorful tapestry in which every thread has a meaning: song and mythology; economy and social organization, trade and craftsmanship; morality and sexual behavior; ritual and ceremony, on the sacred ground or out in the public dancing place. But life for the aborigines no longer follows the pattern of a few generations ago. The coming of the European has brought drastic changes, and these affect even the semi-nomadic tribesmen who know little or nothing of the white man's ways.

FREE AND INEXPENSIVE LEARNING MATERIALS, Division of Surveys and Field Service, George Peabody College of Teachers, 256 pp., $1.50, Nashville, 1959.

The ninth in a series of editions of Free and Inexpensive Learning Materials, this publication is designed to help the teacher, pupil, and librarian collect current sources of information.

This edition contains 4018 entries, 34 per cent of which are revised or new entries. 776 entries in the last edition were eliminated because of the materials out of print, in short supply, or out of date.

With few exceptions, nothing is listed which costs more than 50 cents. Each title is annotated and is followed by the complete address of the distributor. Each pamphlet, poster, picture, chart, and map was selected after it was examined and evaluated. All entries are classified under about 300 common subject headings with extensive cross references.

NOMENCLATURE OF PLANTS, Harold St. John, 157 pp., $2.50, The Ronald Press Co., New York 10, 1958.

A text for the application by the case method of the International Code of Botanical Nomenclature. The cases given are grouped in chapters and the solution of each case is left freely open to each class with the professor and students acting as judge and jury.

Carrot Tumors: Their Use in High School Biology Classes*

DAVID KRAUS, *Far Rockaway High School, New York*
and
EUGENE I. STERN, *George Washington High School, New York*

The formation in carrots of tumors induced by crown-gall bacteria provides a rich field for experimentation by high school students. Although the basic techniques are simple, there is ample opportunity for the design of controlled experiments, for the introduction of quantitative procedures, and for scientific speculation. Since the problem is "cancer-related," it can evoke great student interest, yet the use of plant material obviates the sacrifice of animals by untrained investigators. Experiments designed by pupils can range from the very simple to those which can tax the abilities of the most capable. Students interested in antimetabolites, auxins, and the effects of radiation will find, in carrot tumors, appropriate experimental material which is low in cost and continuously available in the open market.

The general idea is to place a suspension of crown-gall bacteria (*Agrobacterium tumafaciens*) on tissue of ordinary carrots in the laboratory and 15 days later observe the tumors produced. This sounds almost too simple. The interesting complexities arise when students investigate the various phases of the tumor producing process and try to influence this process with chemical and physical agents in order to learn more about growth.

It has been found that the best region in the carrot for development of the tumors is that portion of the phloem which is adjacent to the cambium. Any method of exposing this phloem may be employed. The technique described below is that used by Dr. Richard M. Klein at the New York Botanical Garden wherein thin discs of inoculated carrot tissue are maintained in petri dishes.

Materials

(1) Culture of *A. tumafaciens*. Strain B6, which is highly effective, may be obtained from Dr. Klein, New York Botanical Garden, The Bronx, New York, at the mandated handling charge of $1.00, or from commercial laboratories.

(2) Carrots. These should be of good size and of the strongly "cored" variety as opposed to the slender "coreless" type.

(3) Sterile petri dishes. Sterilize in autoclave with a floor of filter paper in each dish.

(4) Sterile pipettes or medicine droppers. Pipettes are normally sterilized in a covered can by dry heat and kept in the can until used. However, pipettes or medicine droppers may be wrapped in paper and sterilized in an autoclave. A student's oven at home may be used at a temperature of 350° F for 2 hours. Avoid charring the paper.

(5) Cork borer, size #7 (13-mm. diameter) and a steel pusher of slightly smaller diameter.

(6) Alcohol, 70%, for sterilization.

(7) Chlorox.

(8) Miscellaneous: forceps, scalpel, paring knife, potato peeler, paper towelling.

Procedure

(1) *Sterilization of carrot surface.* Peel the carrot with a potato peeler. Cut off the top inch and the bottom 2 inches. Roll the carrot in a cone of paper towelling and pour into the open top enough undiluted Chlorox to moisten the entire surface of the carrot. Close the open end of the cone and allow to rest in a pan for 10 minutes.

(2) *Preparation of carrot discs.* In order to obtain small discs of cambium-adjacent phloem, plugs (or cylinders) of carrot are made using the cork borer; these plugs are then sliced with a scalpel into discs. Detailed directions follow:

A. Put the cork borer, pusher, scalpel, and

*Supported by the Sloan-Kettering Institute for Cancer Research, Memorial Center for Cancer and Allied Diseases, New York, N.Y., as part of a summer work-study program for science teachers, organized by Samuel Schenberg, Director of Science, New York City Board of Education. The program included visiting local scientists in order to collect suggestions for new laboratory experiences for the high school biology curriculum.

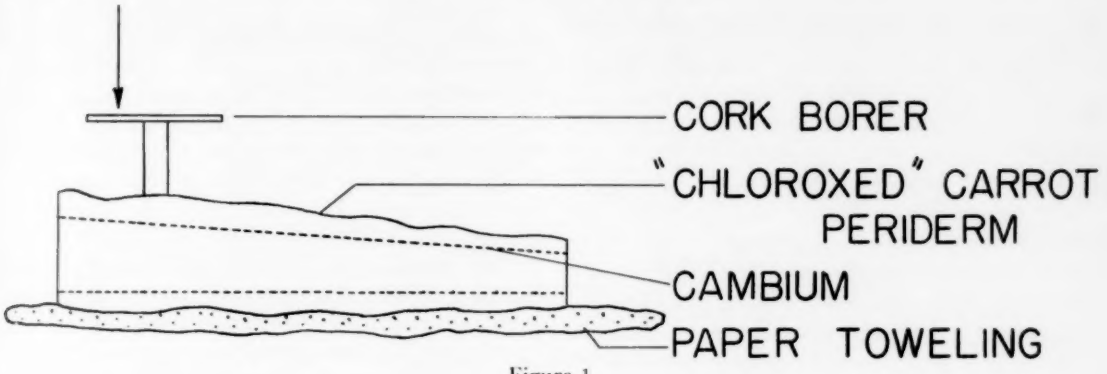

Figure 1

forceps into alcohol. Before use, these instruments are allowed to drain and the remaining alcohol is flamed (*caution!*).

B. Unroll the paper cone; keep the carrot on the paper.

C. Push the cork borer transversely (radially) through the carrot as shown in Figure 1. The carrot should not be handled where the borer is to penetrate. Using the sterilized pusher, push each radial plug out into a sterile petri dish which may be utilized as an operating area. Make as many plugs as needed before proceeding to the next step.

D. From each plug cut two discs, one from each side of the cambium, as shown in Figure 2. Cut *B* is cambium-tangential and should be as close to the clearly-defined cambium as possible without touching it. As the cut is made, flip the disc so that the cambium-adjacent phloem which is to be inoculated is made to turn up. The discs should be 2.5mm. or more in thickness.

E. Transfer each pair of discs to an individual sterile petri dish containing filter paper wetted with sterile water as shown in Figure 3. Complete cutting of all the discs required before proceeding.

(3) *Inoculation.* Inoculate each disc by completely covering the upper surface with a thin film of bacterial culture delivered from a sterile pipette or medicine dropper. Do not over-inoculate.

(4) *Growing the tumor.* Keep discs in the dark at a temperature below 28° C. Room temperature is usually satisfactory. Keep the filter paper saturated by adding sterile water when needed—usually twice weekly. After 6 days the tumor is visible; 15 days after initiation the experiment is concluded.

The tumor appears as yellow to white spherical masses which soon fuse into a continuous sheet of tumor tissue. Lighter in color and softer than normal tissue, the tumor may be removed from the disc with a (non-sterile) scalpel and weighed. Tumor tissue can be handled without danger.

Assay of Carrots for Tumor Growth Capacity

Since individual carrots vary in their capacity to produce tumors, it is often desirable in performing an experiment to conduct a preliminary assay of the reactivity of the carrots used. Carrots are characterized as strong reactors (SR), moderate reactors (MR), or weak reactors (WR). A full range of reactivity is found in bunches of any variety bought on the market. At least 15 genes seem to be involved. A method (7) for classifying carrots to determine their reactivity follows:

(1) Cut off and discard the top inch and the bottom 2 inches of each newly purchased carrot.

(2) Peel the upper inch of the shortened carrot and cut off this top one inch as a slab which will be used for the preliminary assay. Use indelible pencil to identify this slab and the carrot from which it came. Store the long pieces in plastic fruit bags in the refrigerator, preferably at 5°-8° C, for the 15-day assay period.

(3) Sterilize the numbered slabs with Chlorox as described above. Each paper cone may consist of a roll of five or six slabs. Proceed in the usual manner to inoculate discs. At the end of the 15-day period examine the discs and classify the carrots from which they were derived according to the following scheme:

Type of Reactor	*Weight of Tumor per disc*	*Appearance*
SR (Strong reactor)	Above 90 mg.	Entire surface covered by tumor. Papillae touch one another forming a continuous sheet of tumor tissue.
MR (moderate reactor)	20-50 mg.	Intermediate in appearance between SR and WR.
WR (weak reactor)	Below 20 mg.	A few scattered papillae which cover less than 15% of the surface.

Visual classification may be used after considerable experience has been gained.

(4) The large pieces of carrot may now be removed from storage for experimentation. Only the SR and WR individuals are commonly used. There is little loss of reactivity in the carrots during the 15-day storage period.

A Suggested Class Laboratory Exercise

The techniques described above may be readily used in a class laboratory experiment, for example to determine the effects of various physical agents upon the growth of carrot tumors. The introduction of such an experiment early in the biology course can promote the initiation of individual pupil projects. While control petri dishes are kept in the dark, experimental ones may be kept in daylight and in light filtered by colored cellophane sheets wrapped around the dishes. For example,

red light—two layers of red cellophane
green light—one layer of blue, one layer of yellow cellophane
blue light—two layers of blue cellophane.

The effect of lowered temperature may be observed by keeping an experimental dish at 33° ± 1° C while the control is maintained at room temperature. Separate portions of the experiment can be assigned to separate groups of students. Ideally, a pupil-planning session should be devoted to deciding upon the agents to be investigated and to outlining the method to be used.

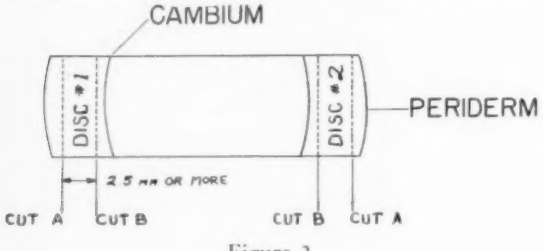

Figure 2

Individual Research Projects

The unveiling of distinct phases in the production of the tumor has provided opportunity for the student to investigate the effects of physical and chemical agents upon the biology of each phase. Although chemical agents are being examined intensively by scientists according to a rational program, so little is known that there is a possibility for a student, using randomly selected materials, such as common household chemicals, to make a significant discovery. Some background information is included at this point in order to orient the student. Appended references can supplement this information. A review of current knowledge concerning crown gall is given by Klein and Link (6).

Tumors grown on carrots through stimulation by crown-gall bacteria (*Agrobacterium tumefaciens*) go through two distinct periods:

I. *Transformation period* (5 days). During this period, normal cells are converted to primary tumor cells. There are three distinct phases:

A.	Conditioning phase (18-20 hours)	Wound substances, released by injured host cells, condition the normal host cells.
B.	Induction phase (60-70 hours)	Bacteria produce a *tumor-inducing principle* (T-iP). This seems to be a desoxyribose-nucleic acid (DNA).
C.	Promotion phase (28-30 hours)	Bacteria produce auxins (indoleacetic acid and other indole compounds).

II. *Duplication period* (10 days). The primary tumor cells resulting from the transformation period multiply rapidly.

Suggestions for student projects follow:

1. Can chemicals modify the induction of

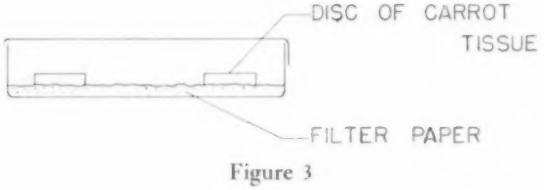

Figure 3

tumor cells or affect their multiplication? Investigate the effect of introducing various chemicals during the individual periods and phases which have been identified. The chemical agents under investigation may be dissolved in the sterile water which is applied to the filter paper or may be dissolved in an agar medium which replaces the filter paper "floor." Agar is desirable because it limits water loss and makes possible the tilting of plates for examination. Agar may be stocked in 1% solution; mix with an equal volume of water to which has been added the soluble chemical, diluting to 0.5% agar. Suggested chemicals are: hormones, auxins, coal tar products, antibiotics, vitamins, mineral salts, anti-metabolites. Consult the literature of chemotherapy (4, 11) for additional suggestions.

2. During which phases of the first period must the bacteria be present? Measure the differences, if any, in tumor production when the bacteria are introduced at the beginning of the various phases.

3. How many bacteria are needed to initiate tumor cell formation? The preparation of dilutions provides an exacting exercise for capable students. Do variations in the number of bacteria, beyond any threshold number, affect the size of the tumor produced?

4. What is the effect of temperature upon tumor production?

5. Does ultra-violet light affect tumor growth?

6. Compare auxin-treated phloem with the growth from bacterial-inoculated phloem.

7. Is there a gradient of reactivity along the length of the carrot?

8. Is wounding of the host cells necessary for tumor production? Permit discs to form a callus. Wound one-half of the surface of the disc by scraping off the callus with a sterile blade; inoculate the entire surface.

9. Compare the histology of normal, callus, and tumor tissue.

10. What is the effect of light of various intensities and wave lengths during each phase of the first period?

11. Observe that the presence of light during the duplication period frequently results in chlorophyll production.

12. What is the effect of removing wound juice? From freshly cut discs wash out the wound juice by immersing in changes of sterile water for 10 hours. What is the effect of heterologous wound juice? Substitute wound juice from beet, parsnip, or potato obtained by macerating the tissue in a Waring Blendor, pressing out the juices, centrifuging, and filtering.

13. Grow various carrot tissues by use of tissue culture techniques described by White (3, 12, 13). Thin discs of tissue consisting largely of cambium give good results. To White's medium add one of the following:

A. naphthalene acetic acid (10^{-5} M)

B. coconut milk (10% by volume). Coconut milk stores well if frozen. White's medium may be made up in 2x or 4x concentration and diluted when needed with coconut milk and water. White (13) appends a section entitled "Simple Techniques for Beginners."

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Report of Cooperative Committee on Teaching of Science and Mathematics

The fall meeting of the AAAS Cooperative Committee on the Teaching of Science and Mathematics was held in Washington, D. C., October 23 and 24, 1959. Announcement was made of the award of a grant from the Carnegie Corporation of New York for a study of teacher certification in science and mathematics by the National Association of State Directors of Teacher Education and Certification. This study will attempt to provide a basis for national standards in teacher certification in science and mathematics and provides both for regional agreements and deliberations as well as decisions within the states.

The subcommittee appointed to consider the establishment of model high schools for science teacher training reported that preliminary plans were formulated for obtaining financial support. The group forsaw problems in connections with (1) the considerable distances of travel required for teachers to visit model high schools if they were established on a regional basis, (2) the availability of travel funds, and (3) the value of observing a small sample (one or two days) of teaching under optimum conditions. It was felt that if model schools departed too widely from typical schools, teachers would be discouraged from attempting to introduce the practices they observed into their own teaching situations. There was some discussion on whether demonstration schools connected with teacher institutions meet the criteria for consideration as model schools and whether it would be desirable for the model high schools envisioned in the proposal to be connected with university schools of education. The views of T. M. Stinnett of the National Commission on Teacher Education and Professional Standards were: (1) that state departments of education should be involved in the selection of model schools in their states and in the development of the model programs, (2) the model high schools should not be schools for gifted students but should be comprehensive high schools, and (3) that university high schools might be used as model schools.

A revised report of the subcommittee on teacher certification is being prepared and will be published in *Science* in the near future. The biology section of this report is elsewhere in this issue.

Representatives of teaching organizations were requested to obtain views of their respective societies on a proposal for identifying and recognizing superior teachers. The possibility of using the National Teachers Examination as a means for identifying well qualified teachers was discussed, but it was realized that it is frequently difficult to evaluate teaching competence as distinguished from subject matter competence. A motion was also passed to obtain views of organizations represented on suggestions for certification requirements in science for elementary teachers and action needed to improve the content of elementary science.

It was announced that recent legislation had provided a grant of $50,000 to the Office of Education to consider the promotion of science clubs, fairs, junior academies of science, etc., for high school students. One aspect of the grant is an attempt to bring about better coordination of current activities of this kind.

A subcommittee was appointed to study the matter of professional education requirements for science teachers. It was urged that scientists take a constructive attitude toward professional education.

The Spring meeting of the Committee will be held at North Carolina State College, Raleigh, on March 11 and 12, 1960.

Brother G. Nicholas, F.S.C.
Department of Biology
University of Notre Dame
Notre Dame, Indiana

Motor vehicle accidents killed 36,700 and injured 2,825,000 on U. S. highways during 1958.

Speed was blamed for more than 40 per cent of the traffic deaths and injuries in the U. S. during 1958.

Book Reviews

THE BIOLOGICAL WAY OF THOUGHT, Morton Beckner, 200 pp., $6.00, Columbia University Press, New York 27, 1959.

Here are described the special methods of concept formation and explanation that distinguish biology from the other natural sciences. The method of approach is dual: through a logical analysis of historical, functional, and polytypic concepts and an examination of their role in achieving theoretical unification; and through a logical analysis of model explanation, teleology and historical explanation.

SECURITY FOR ALL AND FREE ENTERPRISE, Henry I. Wachtel, 162 pp., $3.00, Philosophical Library, New York, 1955.

This is a summary of the social philosophy of Josef Popper-Lynkeus who believed that no socialist system can prevail for any length of time without an individualistic phase, because the longings for human liberty remain more natural and elemental than the strivings for equality. His social order therefore leads from unjust inequality in capitalist society over equality in the "Guaranteed Minimum for Subsistence for All" sector, to a just inequality in "Free Enterprise."

THE NATURE OF THINGS, Don Hawley, 187 pp., $3.75, Philosophical Library, New York, 1959.

This book is a bold challenge against the spiritual pessimism caused by the use of materialism in science. It views the Universe as a Spiritual-Material continuum and formulates a general mystical-philosophical-scientific picture of everything from the microcosm to the macrocosm while not refusing to accept the probability of nonsensual reality.

THE ANATOMY OF THE MIGRATORY LOCUST, F. O. Albrecht, 118 pp., $6.00, University of London, The Athlone Press, 1953.

A comprehensive account of the external and internal anatomy of the migratory locust, providing a background for current research and a storehouse of fact to which many field workers engaged in locust control will find it convenient to refer. The book is also designed to serve in the teaching of general entomology. Mr. Albrecht has included instructions on the best methods for dissecting a locust and for the demonstration of its structure.

FELLOWSHIPS IN THE ARTS AND SCIENCES, 1960-1961, Third Edition, Virginia Bosch Potter, 220 pp., $3.75, American Council on Education, Washington, 1959.

This is the latest listing of the opportunities available for a variety of students. There is an interesting introduction with good advice for all who apply for fellowship or loan assistance. Divisions of the book are headed with general descriptive matter about the opportunities. Those divisions are Predoctoral Fellowships, Postdoctoral Fellowships, Senior Faculty Awards, Study Abroad, Summer Study, and Loans. A useful book for college or municipal libraries.

P. K.

Lung Cancer

A lower incidence of lung cancer among women than among men today is largely a reflection of difference in male and female smoking habits, says Dr. Ernest L. Wynder of the Division of Preventive Medicine, Sloan-Kettering Institute for Cancer Research, New York. One of the most striking points about lung cancer, according to Dr. Wynder, is the predominant ratio of men among its victims, estimated at 5 to 1. In the early 1900's, the incidence of lung cancer, then a rare disease, was reported to be about equal between men and women, Dr. Wynder said. Since that time, the incidence among men has risen 20-fold and that among women only four-fold, he reported. In 1954, he said, some 25,000 Americans died of lung cancer, of whom 4,000 were women.

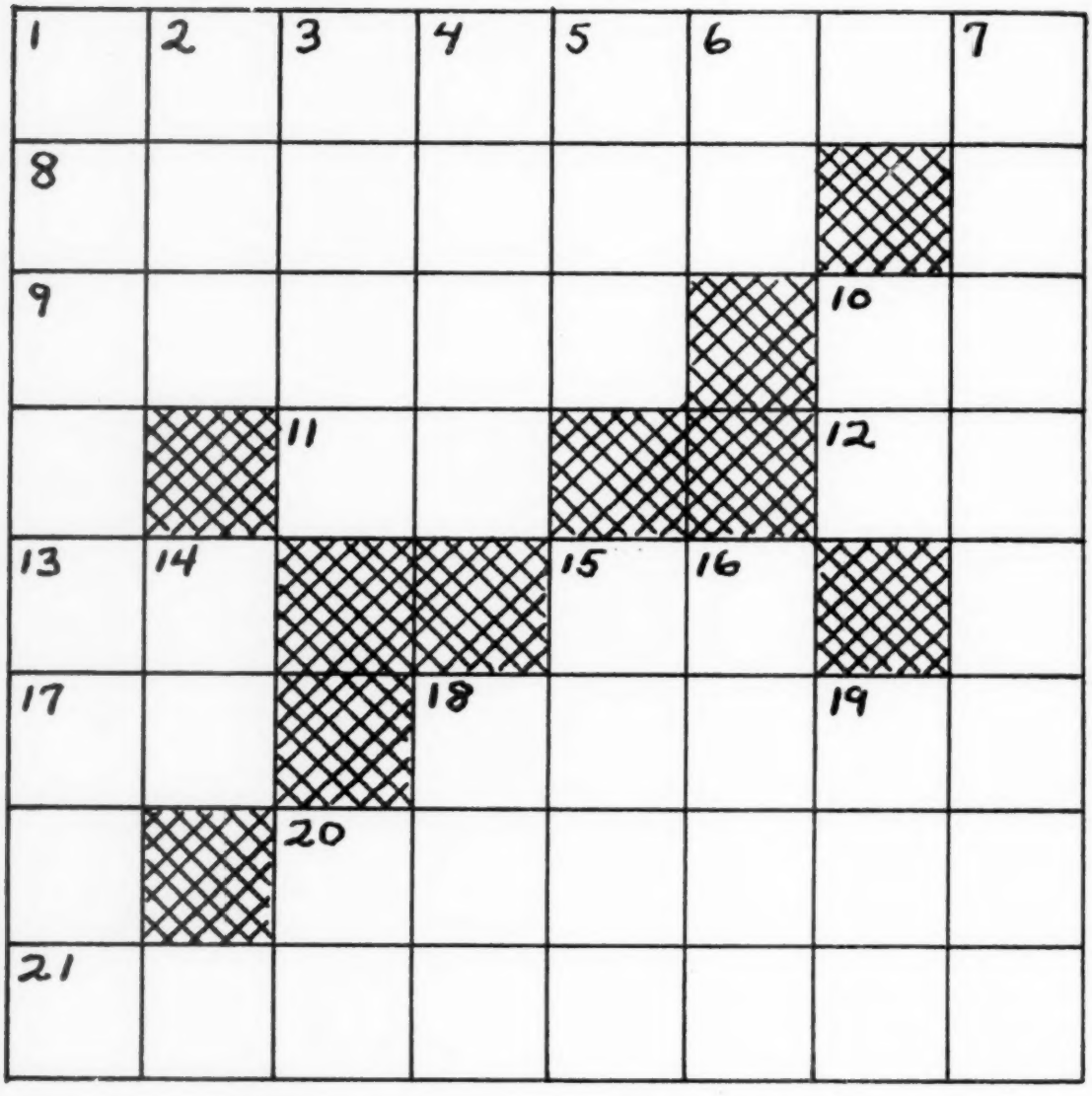
Crossword Puzzle—Page 102

1 N	2 E	3 M	4 A	5 T	6 O	D	7 A
8 A	M	E	B	A	S	■	L
9 C	U	T	I	N	■	10 A	V
R	■	11 A	O	■	■	12 I	E
13 E	14 U	■	■	15 H	16 A	■	O
17 O	S	■	18 S	E	P	19 A	L
U	■	20 D	E	M	O	T	U
21 S	Y	N	A	P	S	E	S

Crossword Puzzle

ROBERT G. FRANKE

7628B N. Rogers Ave., Chicago 26, Illinois



DOWN

1. Pertaining to the mother-of-pearl shells of certain mollusks
2. A large Australian bird
3. ----zoan: animal with more than one cell
4. Prefix indicating "without life"
5. Darken the skin pigment with sunlight
6. Mouth (anat.)
7. Thin walled air-filled sac in the vertebrate lung
10. Three-toed sloth
14. Latin abbreviation for "as above"
15. Marijuana
16. Army Post Offices (abbr.)
18. Where life probably began
19. Chemical suffix
20. Dentalman (U. S. Navy abbr.)

ACROSS

1. Phylum of animals including roundworms
8. Single-celled animals of irregular shape
9. Material of which the plant cuticle is composed
10. Auriculo-ventricular (abbr.)
11. Assamese language
12. Latin abbreviation for "that is"
13. --glena: animal with chloroplasts
15. Hospital apprentice (U. S. Navy abbr.)
17. A bone (anat.)
18. Part of a calyx.
20. -- ----- *animalum*: biological work by Borelli in 17th century (2 words)
21. Conjugation of pairs of homologous chromosomes (pl.)

Solutions to Puzzle on page 101

Book Reviews

LAMINATED ANATOMY STUDY CARDS, Student Merchandise, Inc., 350 Fifth Avenue, New York 1, 1959. $2.50 per set. Set No. 1 (Bones, Muscles, Muscle Insertions), Set No. 2. Arteries, Veins, Nerves, Lymphatics), Set No. 3 Comparative anatomy of cat, Necturus, frog, and shark).

A special discount of 20% will be available to NABT members for these cards. They are playing card size, plastic, and well constructed, showing all the appropriate labels. Each box contains 21 cards with Set No. 2 in colors. These will be very handy for reviews of the anatomical terms involved both for student and teacher. Many teachers will find these as handy, compact references on the anatomy of the human as well as for comparative purposes in the animals named. Highly recommended for high school and college use. Terms are completely listed.

P. K.

GENERAL AND INVERTEBRATE ZOOLOGY: A LABORATORY MANUAL, Benson Ellis, 250 pp., $4.00, N-P Publications, Palo Alto, California, 1959.

An effectively written manual with very few illustrations as it is based on the texts of Buchsbaum and Storer. Each exercise has full directions with selected texts as references. Mammal used is the rat. There are extra credit projects included as well as directions for project work.

P. K.

1957 RESEARCH CONFERENCE ON THE IDENTIFICATION OF CREATIVE SCIENTIFIC TALENT, Calvin W. Taylor, 255 pp., $5.00, University of Utah Press, Salt Lake City, Utah, 1958.

A report of a conference sponsored by NSF to take up the problem of creativity. The reports are mostly psychological in nature, but Professor Eyring adds a first-hand note from a scientist. Useful for those interested in the characteristics of a scientist and a creative person.

P. K.

FUNCTION OF THE HUMAN BODY, Arthur C. Guyton, 584 pp., W. B. Saunders Co., Philadelphia, 1959.

This text accomplishes exactly what the author promised it would in the preface. It is specifically designed for beginning students with a limited background in chemistry and physics. The book is a general survey of human physiology suitable for a liberal arts or nursing program. With the exception of the skeletal and muscular systems, sufficient anatomy is included to permit a sound consideration of physiological functions. Undoubtedly due to the medical background of the author, the physiology of the organ systems is related to certain diseases and afflictions. This commendable approach bridges many a gap between theory and practice. The text is well written and easily read. The figures are well executed and have the facility of making a difficult concept appear most lucid. A brief but up-to-date list of references follows each chapter.

Only a few errors were noted. On page 23 it is stated that urea forms inside many cells, and the accompanying diagram shows urea leaving the cell as a consequence of cellular metabolism. Urea formation is almost totally confined to liver cells. On page 233 the enzyme carbonic anzhydrase is said to speed up the reaction of carbon dioxide and water to form carbonic acid. Since this enzyme is one of the lyases, it does just the opposite. A typographical error was noted on page 473. A caloric equivalent of 4.05 calories is given for the consumption of one liter of oxygen in metabolizing pure carbohydrate. It should be 5.05 calories.

Francesco Trama, Chicago Teachers College

THE EDUCATION OF THE INDIVIDUAL, Alfred Adler, 143 pp., $3.50, Philosophical Library, New York, 1958.

In the rage of the controversy of educating for the gifted child or for the average child, Dr. Adler reminds us of the significance of each individual at any given moment of his life.

An Edible Approach to Biology

HERBERT H. HARPER
Forest Lake High School, Forest Lake, Minnesota

The past two years my senior high conservation and two biology classes have come to appreciate biology in a somewhat different manner. The idea began five years ago with my students collecting such items of food as wild ducks, venison, squirrel, and rabbits. The items were then prepared and served by the advanced home economics students to the biology students during school hours. Each year the items on the menu increased. A year ago the biology and conservation students decided to also prepare the food, serve it in the school cafeteria, and invite their parents and a few friends. A borrowed AO Cycloptic binocular microscope was on display, and as guests left, they made a donation toward the purchase of the instrument.

The dinner was a success in that over 200 people consumed such items as five large roast raccoon, about fifty squirrels, over 250 pairs of frog legs, (our Leopard Frogs don't compare in size with Bull Frogs), smoked smelt, woodchuck, and water-cress salad. People—both students and parents— not accustomed to eating such foods, found they had been passing up some delectable foods.

This year even more items were added to the menu, and again the food was well prepared. Early in the school year, students volunteered to try to bring particular items of food. Admittance to the dinner is obtained by each student bringing enough food to feed himself, his parents and guests. A search was made by students and parents for tested recipes—or a friend who has shot a bear or has a moose roast that they will donate.

Many efforts are necessary to find all the food. Basswood tree blossoms were picked in their prime during early July and dried in the shade to keep their flavor as is commonly done in Germany today. Bark from the roots of the sassafras tree came from Kentucky—for tea the flavor of root beer. Cattail shoots, the succulent young sprouts for next year's growth, are under water and require plenty of cold work to get. Our Leopard Frog population was quite low this year, so we relied on a few donated Bull Frog legs from the South. A very early freeze-up and several inches of ice resulted in our not having our usual water-cress salad. A wild strawberry moulded salad took its place.

One girl located a source for bear and brought five roasts. A local bait dealer who attended the dinner last year, furnished a full bushel of crayfish, and a full day was spent by all students in their free class periods, boiling, shucking, and freezing the tiny crayfish tails. These tiny morsels are better than lobster or shrimp.

Carp from the State Conservation Department, smoked with applewood by a local butcher, tasted like Kentucky smoked ham. The school counsellor appeared with a fine young sulphur shelf fungus. The manager of a game farm contributed expensive wild rice.

One student made arrangements with a local sportsman to show his movies of a trip to the Northwest Territory of Canada, beyond the Arctic Circle. He also contributed a large roast of moose!

Deer hearts were stuffed the day before the dinner, to be served cold. Two snapping turtles on exhibit at the State Fair became prize items of food. Some students shot blackbirds, not on the protected list, others trapped muskrat, another brought a porcupine roast. Still others brought black walnuts and butternuts or used them to make nut bread or fudge. Others baked pies and bread and contributed favorite wild jams and jellies.

One student, with a knowledge of cooking gained from his father, a chef, took charge of preparing the meat. Other students assumed the job of organizing the dinner. Students volunteered for the complete preparation and serving of each food. The girls who collected the dandelion greens had experimented with recipes at home. As methods of cooking were decided upon, other students prepared the menu. The home economics teacher offered advice and the use of stoves and equipment. Cafeteria cooks were hired to supervise the use of their equipment.

The day of the dinner was a busy one, all students working during their "free" periods

and from the end of the school day until well after the meal was finished. All food was labeled and served smorgasbord style. A few people missed their coffee but were pleased with the tasty crayfish tails, sulphur shelf fungus, roast bear, or braised snapping turtle. The movies were most unusual and fitted in with the menu. Money taken in through donations this year, over expenses of cafeteria help and a few groceries, as this is not intended to be a money-raising project, will go to students to use for their biology and conservation projects.

Students have participated in new experiences and some hard work, from cleaning squirrels and crayfish, trimming early winter fat from raccoon and bear, cracking walnuts and preparing shelf fungus, and perhaps have gained a better appreciation for "wild" local foods. Perhaps, too, they have more appreciation of some problems of our pioneers, eating customs of different localities and nationalities, and were also rewarded with some excellent food. Parents, too, often found their earlier notions about what is or is not edible needed to be revised. Then come ideas for next-year's dinner . . . and promises of donations of food!

Fifth Annual Wildlife Dinner
Biology and Conservation Classes
Forest Lake High School
18 November 1959

Crayfish Cocktail
Wild Strawberry Molded Salad
Tossed Dandelion Greens
Inky Capand Shaggymane Mushroom Gravy
Butter Fried Sulphur Shelf Fungus
Wild Rice Roasted Cattail Shoots
Cold Stuffed Heart of Venison Canadian Venison Cakes
Round Venison Steak Venison Liver in Tomato Sauce Boiled Venison Ribs
Roast of Moose Roast of Bear Roast of Western Antelope
Baked Raccoon with Celery and Sage Dressing
Breaded Gray Squirrel Broiled Fox Squirrel
Broiled Cottontail Rabbit in Hawaiian Sauce
Jack Rabbit Fry Roast of Porcupine Braised Muskaush (Muskrat)
Roast Mallard Duck with Celery and Sage Dressing
Roast Northern Redhead Duck
Roast Blue-winged Teal with Wild Rice Dressing
Celery and Sage Stuffed Pheasant
Fried Pheasant Roasted Canadian Goose Fried Ruffed Grouse (Partridge)
Roast Blackbird with Celery and Sage Dressing
Roast Coot (Mudhen) with Bread Sausage Dressing
Deep fried Crayfish Tails
(Fresh Water Crabs)
Deep fried North Superior Smelt
French fried Bull Frog Legs
Fried Northern Pike Fried Brook Trout
Applewood smoked Carp Braised Snapping Turtle
Sulphur Shelf Fungus fried in butter
Wild Blueberry Pie Wild Apple Pie Blackbery Pie
Dewberry Pie
Cranberry Bread Blueberry Bread Black Walnut Bread
Chokecherry Jelly Ground Cherry Jam North Swamp Cranberry Jelly
Blackberry Jelly Wild Grape Jelly
Wild Currant Jelly Wild Strawberry Jam
High Bush Cranberry Relish Black Walnut Fudge Bar B-Q Relish

Lindenblüt tea (Basswood)
Butter Nut Fudge
Iced Sassafras tea
Hot Sassafras tea

NSF Summer Institutes for Biology Teachers

The National Science Foundation will support 381 Summer Institutes in 1960. However, listings of all these are available only to teachers on request to the NSF. Therefore, the following list of Institutes are of especial interest to biology teachers compiled from the information available.

The Foundation grant to each Institute covers the cost of tuition, fees, stipends, and allowances. The Institute, in turn, selects the teacher-participants and determines the amounts of the stipends and allowances. The maximum stipend is $75 per week; the maximum dependency allowance is $15 per week per dependent up to four; the maximum travel allowance is $80, calculated at 4 cents per mile for one round trip between home and Institute. Institutes are permitted to offer smaller sums in order to accommodate more teachers.

Application blanks are obtained only from host institutions and NOT from the National Science Foundation. The completed application blanks (including in every case a card for the National Science Foundation) must be postmarked by *February 15, 1960*, to guarantee consideration. Institutes will make initial stipend offers on or before *March 15, 1960. In every case, recipients will have until April 1, 1960, to accept or decline.*

Many Institutes select a list of alternates, to whom stipends may later become available. *If an applicant is offered alternate status by an Institute, he should notify the Institute Director if he does not wish to be considered as an alternate or if he accepts a stipend elsewhere.*

Transcripts of credits and letters of reference will not be needed by Directors of some Institutes, and should be sent *only to those Directors who request them.* However, the applicant himself will find it necessary to refer to his college credit transcripts in providing some of the information required in the application blanks. Therefore, unless he already has them at hand, he may wish to obtain a copy of each of his college transcripts while waiting to receive the application blanks from the Institutes to which he writes for information.

To provide guidance for teachers in their choice of Institutes best suited to their needs, backgrounds, and teaching levels, each Director was asked to supply certain information in addition to listing the subject matter to be covered. The code symbols after each entry in this brochure correspond to those of the following statements which were checked by the Director as best describing his Institute.

The Institute is designed for teachers in

(JH) junior high school
(SH) senior high school
(JC) junior college
(C) college (which would ordinarily include junior college unless specifically stated otherwise in the local brochure)
(TI) technical institutes and technical curricula in junior colleges

The Institute is designed for teachers characterized by the following statements:

(1) Background training weak or insufficient—need additional training in basic subject matter.
(2) Background adequate, but acquired too long ago—need training in modern aspects of basic subject matter.
(3) Background training reasonably good and up-to-date—need training at more advanced level to increase grasp of subject matter.
(4) Background training good, up-to-date—need training in specialized area.

The following entries give essential information concerning individual institutes. Requests for further information and for application blanks should be sent to the person whose name is given in each of the following entries. In those cases in which inquiries and applications are to be addressed to an individual other than the Institute Director, both names are included; correspondence should be sent to the person whose name is listed last.

INSTITUTES FOR COLLEGE TEACHERS

Biology

Arizona State University, 6 weeks, June 27-August 6: *The Biology of the Desert;* for teachers of biology. Dr. Gordon L. Bender, Department of Zoology, Arizona State University, Tempe, Ariz. (C; 4)

University of Colorado and American Society of Zoologists, 6 weeks, June 27-August 5: *Animal Ecology;* primarily for teachers of animal ecology and general ecology. Prof. Robert W. Pennak, Department of Biology, University of Colorado, Boulder, Colo. (C; 2, 3)

North Carolina State College, 6 weeks, June 7-July 15: *Genetics;* for teachers of genetics and biology. Dr. H. F. Robinson, Department of Genetics, 353 Gardner Hall, North Carolina State College, Raleigh, N.C. (C; 1, 2)

University of Oregon, 8 weeks, June 20-August 12, at Oregon Institute of Marine Biology, Charleston, Oregon: *Biology of Marine Organisms;* for teachers of biology. Dr. Richard W. Castenholz, Department of Biology, University of Oregon, Eugene, Oregon. (C; 4)

Oregon State College, 8 weeks, June 20-August 12: *Biochemistry for Biologists; Biophysics for Biologists; Radiation Biology; Cell Biology and Cytogenetics; Experimental Embryology; The Nervous System and Behavior; Seminar in College Biology Teaching;* for teachers of biological sciences. Dr. Howard H. Hillemann, Oregon State College, Corvallis, Oregon. (C; 1, 2, 3)

Radiation Biology

(Sponsored jointly with the Atomic Energy Commission)

State University of Iowa, 8 weeks, June 14-August 10: *Radiation Biology;* for teachers of physiology, biology, zoology, physics, and chemistry. Dr. Titus C. Evans, Radiation Research Laboratory, College of Medicine, State University of Iowa, Iowa City, Iowa. (C; 3, 4)

The University of Michigan, 8 weeks, June 20-August 12: *Radiobiology; Uses of External Radiation and Radioactive Tracers;* for teachers of life science. Assistant Prof. Melvin Levine, Department of Biological Chemistry, the University of Michigan, Ann Arbor, Mich. (C; 4)

Syracuse University, 6 weeks, July 5-August 12: *Radiation Biology; Radiation Physics;* for teachers of biology. Dr. M. W. Jennison, Department of Bacteriology and Botany, Syracuse University, Syracuse 10, N.Y. (C; 2, 3, 4)

Tulane University, 8 weeks, July 5-August 26: *The Effects of Radiation on Biological Sysetms;* for teachers of science. Dr. John K. Hampton, Jr., Department of Physiology, Tulane School of Medicine, Tulane University Station, New Orleans 18, La. (C; 4, 5)

University of Washington, 8 weeks, June 20-August 12: *Radiation Biology;* for teachers of science. Prof. Arthur D. Welander, University of Washington, Seattle 5, Wash. (C, 4)

INSTITUTES FOR HIGH SCHOOL AND COLLEGE TEACHERS

Biology

University of California, Santa Barbara, 6 weeks, June 22-August 1: *Marine Zoology; Marine Botany; Physical Oceanography;* for teachers of biology. Dr. Edward L. Triplett, Department of Biological Sciences, University of California, Santa Barbara, Goleta, Calif. (SH, C; 1, 2)

Radiation Biology

(Sponsored jointly with the Atomic Energy Commission)

Florida State University, 8 weeks, June 11-August 6: *Radiation Biology;* for teachers of biology. Dr. Charles W. Edington, Department of Biological Sciences, Florida State University, Tallahassee, Fla. (SH, JC; 2, 3, 4)

University of Hawaii, 6 weeks, June 20-July 30: *Isotopic Tracers in Biology; Biological Aspects of Radiation;* for teachers of biology. Dr. Sidney C. Hsiao, Department of Zoology, University of Hawaii, Honolulu 14, Hawaii. (SH, C; 3, 4)

Multiple Fields

Colorado College, 8 weeks, June 20-August 12: *Biology; Chemistry; General Science; Mathematics; Physics;* for teachers of biology, chemistry, general science, mathematics, and physics. Dr. Richard G. Beidleman, Colorado College, Colorado Springs, Colo. (JH, SH, JC; 2, 3)

The University of Mississippi, 10-3/5 weeks, June 9-August 21: *Biology; Chemistry; Mathematics; Physics; and Geology;* for teachers of biology, chemistry, mathematics, physics, and general science. Dr. George Vaughan, Department of Chemistry, the University of Mississippi, University, Miss. (JH, SH, JC; 2, 3)

Mississippi State University, 11 weeks, June 6-August 20: *Botany; Zoology; Chemistry; Mathematics; Physics; General Science;* for teachers of the physical and biological sciences and mathematics. Dr. Clyde Q. Sheely, Department of Chemistry, Mississippi State University, State College, Miss. (JH, SH, JC; 2, 3)

College of William and Mary, 8 weeks, June 20-August 12: *Principles of Biology; Principles of Chemistry; Fundamental Concepts of Mathematics; Modern Geometry; Principles of Physics;* for teachers of science and mathematics. Dr. Melvin A. Pittman, Department of Physics, College of William and Mary, Williamsburg, Va. (JH, SH, JC; 2, 3, 4)

INSTITUTES FOR HIGH SCHOOL TEACHERS

Biology

Ball State Teachers College, 10 weeks, June 13-August 19: *Biophysics; Biochemistry; Genetics; Ecology;* for teachers of biology. Dr. Jerry J. Nisbet, Department of Science, Ball State Teachers College, Muncie, Ind. (JH, SH; 1)

Boston University, 6 weeks, July 11-August 20, at Osgood Hill Conference Center, North Andover, Mass.: *Advances in Experimental Biology; Entomology; Biology of Woody Plants; Comparative Vertebrate Anatomy; Physiology;* for teachers of biology. Dr. George P. Fulton, Department of Biology, Boston University, 675 Commonwealth Avenue, Boston 15, Mass. (JH, SH; 1, 3, 4)

University of Colorado, 7 weeks, June 20-August 5: *General Bacteriology; Independent Study in Bacteriology; Seminar;* for teachers of biology and general science. Mr. Charles R. Bitter, Department of Biology, Denison Lab 207, University of Colorado, Boulder, Colo. (SH: 3, 4)

University of Colorado, 6 weeks, June27-August 6: *Dynamics of Biological Systems; The Development of Biological Ideas;* for teachers of biology. Dr. Newell Younggren, Department of Biology, University of Colorado, Boulder, Colo. (JH, SH; 1, 2)

Howard University, 8 weeks, June 20-August 12: *Radiation Biology; Modern Perspectives of Biology;* for teachers of biology. Dr. Marie C. Taylor, Howard University, Washington 1, D. C. (SH; 2)

Indiana University, 4 weeks, June 27-July 22: *Bacteriology;* for teachers of biology. Prof. L. S. McClung, Department of Bacteriology, Indiana University, Bloomington, Ind. (SH; 1, 4)

Indiana University, 6 weeks, June 20-July 29: *Biology;* for teachers of biology. Prof. Shelby D. Gerking, Department of Zoology, Indiana University, Bloomington, Ind. (SH; 2, 3)

Louisiana Polytechnic Institute, 9 weeks, June 6-August 5: *Field Biology;* for teachers of biology. Dr. John A. Moore, Box 654, Tech Station, Ruston, La. (SH; 1, 2)

Marquette University, 6 weeks, June 20-July 29: *Physiology; Cell and Development; Genetics and Environment Biology;* for teachers of biology. (Director of Program: Dr. Clarence F. Dineen, St. Mary's College, Ind.) Dr. Rezneat M. Darnell, Department of Biology, Marquette University, Milwaukee 3, Wis. (SH; 2, 3)

University of Minnesota, 5 weeks, June 13-July 16, at the Lake Itasca Forestry and Biological Station: *Basic Instruction in the Field and Laboratory With Experience in Biological Research at a Summer Field Station;* for teachers of biology. Dr. William H. Marshall, Summer Session, 135 Johnston Hall, University of Minnesota, Minneapolis 14, Minn. (SH; 3, 4)

University of Missouri, 8 weeks, June 13-August 5: *Principles of Biology; Intermediate Botany; Intermediate Zoology;* for teachers of biology. Dr. Robert F. Brooks, 100 Lefevre Hall, University of Missouri, Columbia, Mo. (SH; 3)

Northwestern State College, 9 weeks, June 7-August 6: *Principles of Biology; Bacteriology; Mammalian Physiology; Genetics; Field Zoology;* for teachers of biology. Dr. W. G. Erwin, Department of Biological Sciences, Northwestern State College, Natchitoches, La. (JH, SH; 1, 2, 3)

Purdue University, 8 weeks, June 11-August 5: *Plant Physiology; Microbiology; Seminar in Teaching of High School Biology; Special Assignments in Biology;* for teachers of biology. (Director of Program: Prof. Jesse R. Singleton, Purdue University.) Dr. J. D. Novak, Department of Biological Sciences, Purdue University, West Lafayette, Ind. (SH; 2, 3)

University of Rhode Island, 6 weeks, July 5-August 12: *Field Biology and Ecology;* for teachers of biology. Prof. Elmer A. Palmatier, Department of Botany, University of Rhode Island, Kingston, R. I. (SH; 1, 2)

Rutgers, The State University, 6 weeks, July 6-August 12: *Genetics and Evolution;* for teachers of biology. Dr. Alan A. Boyden, Department of Zoology, Rutgers, The State University, New Brunswick, N.J. (SH; 2, 3, 4)

SAN JOSE STATE COLLEGE, 6 weeks, June 27-August 5: *Biology*; for teachers of biology. Dr. Charles E. Smith, Jr., Science, San Jose State College, San Jose, Calif. (JH, SH; 1, 2)

SIMMONS COLLEGE, 6 weeks, June 27-August 9: *Physico-Chemical Basis of Living Tissue; Nutrition and Metabolism of Cells;* for teachers of biology. Prof. Philip M. Richardson, Head, Department of Biology, Simmons College, Boston 15, Mass. (SH; 1, 2)

UNIVERSITY OF SOUTHERN CALIFORNIA, 6 weeks, June 20-August 29: *The Organism and Its Environment; A Study of Recent Advances in Biology;* for teachers of biology. Dr. Jay M. Savage, Department of Biology, University of Southern California, Los Angeles 7, Calif. (SH; 2, 3)

SOUTHERN ILLINOIS UNIVERSITY, 8 weeks, June 19-August 12: *Botany; Microbiology; Zoology;* for teachers of biology. Dr. I. L. Shechmeister, Department of Microbiology, Southern Illinois University, Carbondale, Ill. (SH; 1)

SOUTHERN METHODIST UNIVERSITY, 6 weeks, June 4-July 15: *Field Biology;* for teachers of biology and general science. Dr. Joe P. Harris, Jr., Southern Methodist University, Dallas 5, Tex. (JH, SH; 2, 3)

STEPHEN F. AUSTIN STATE COLLEGE, 6 weeks, June 1-July 8: *Field Biology;* for teachers of biology. Dr. Alvin F. Shinn, Department of Biology, Stephen F. Austin State College, Nacogdoches, Tex. (SH; 3)

SYRACUSE UNIVERSITY, 6 weeks, July 5-August 12: *Microbiology; Statistics for Biology Teachers; Genetics; Aquatic Biology;* for teachers of biology. Prof. John Burdick, 400 Lyman Hall, Syracuse University, Syracuse 10, N. Y. (SH; 1, 2, 3)

TEXAS TECHNOLOGICAL COLLEGE, 9 weeks, June 1-August 2: *Principles of Biology; Basic Concepts of Modern Biology;* for teachers of biology and general science. Dr. Earl D. Camp, Department of Biology, Texas Technological College, Lubbock, Tex. (JH, SH; 1, 2, 3)

TULANE UNIVERSITY, 6 weeks, June 20-July 29: *Current Biological Concepts and Significant Trends;* for teachers of biology. Prof. E. Peter Volpe, Department of Zoology, Newcomb College of Tulane University, New Orleans 18, La. (SH; 3, 4)

UNIVERSITY OF WISCONSIN—MILWAUKEE, 6 weeks, June 20-July 30: *Field Biology;* for teachers of biology. Prof. Peter J. Salamun, Department of Botany, University of Wisconsin, Milwaukee 11, Wis. (SH; 1, 2, 3)

WISCONSIN STATE COLLEGE, 6 weeks, June 12-July 23, at Pigeon Lake Camp, Chequamegon National Forest: *Biology and Field Biology;* for teachers of science. (Director of Program, Mr. Eugene R. McPhee, Director of State Colleges.) Dr. James Unger, Wisconsin State College, Oshkosh, Wis. (JH, SH; 1, 2, 4)

Radiation Biology

(Sponsored jointly with the Atomic Energy Commission)

ADELPHI COLLEGE. (See listing under Multiple Fields.)

UNIVERSITY OF ARKANSAS, 7 weeks, July 18-September 2, at University of Arkansas Medical Center, Little Rock, Ark. *Radiation Biology;* for teachers of biology, physics, and general science. Prof. Horace N. Marvin, Department of Anatomy, University of Arkansas Medical Center, Little Rock, Ark. (SH; 1, 2)

BOWDOIN COLLEGE, 6 weeks, June 27-August 6: *Radiation Biology; Basic Electronics, Atomic and Nuclear Physics;* for teachers of science. Prof. Noel C. Little, Department of Physics, Bowdoin College, Brunswick, Maine. (SH; 2, 4)

UNIVERSITY OF CALIFORNIA, LOS ANGELES, 6 weeks, July 11-August 19: A unified course including *Introductory Nuclear Physics, Mathematics Review, Radiation Biology, and Applied Nuclear Physics;* for high school teachers of science. Dr. Raymond L. Libby, Department of Radiology, UCLA Medical Center, Los Angeles 24, Calif. (JH, SH; 3, 4)

DUKE UNIVERSITY, 8 weeks, June 20-August 12, at Duke University Marine Laboratory, Beaufort, N.C.: *Survey of Marine Biology; Radiation Physics and Chemistry; Radiation Biology; Laboratory Work with Radioactivity;* for biology teachers. Dr. Donald J. Fluke, Department of Zoology, Duke University, Durham, N.C. (SH; 4)

HOWARD UNIVERSITY. (See listing under Biology.)

THE UNIVERSITY OF KANSAS, 8 weeks, June 13-August 6: *Biological and Physical Foundations of Radiation Biology; Basic Radiation Biology;* for teachers of biology, chemistry, physics, and general science. Dr. Edward I. Shaw, Radioactive Isotopes Research Laboratory, The University of Kansas, Lawrence, Kans. (JH, SH; 4)

UNIVERSITY OF MINNESOTA, 6 weeks, June 13-July 23, at Institute of Agriculture, St. Paul, Minn.: *Radiation Biology;* for teachers of biological science. Dr. F. A. Spurrell, College of Veterinary Medicine, Room 120 Veterinary Clinic, University of Minnesota, St. Paul 1, Minn. (SH; 2, 3, 4)

MONTANA STATE UNIVERSITY, 8 weeks, June 18-August 14, at University Biological Station, Bigfork, Mont.: *Radiation Biology;* for teachers of biology, chemistry, and physics. Dr. LeRoy H. Harvey, Department of Botany, Montana State University, Missoula, Mont. (SH; 2, 3, 4)

UNIVERSITY OF NEW MEXICO, 9 weeks, June 13-August 14: *Radiation Biology; Basic Electronics; Atomic and Nuclear Physics;* for teachers of science. Dr. Loren D. Potter, Department of Biology, University of New Mexico, Albuquerque, N. Mex. (SH; 3, 4)

THE OHIO STATE UNIVERSITY. (See listing under Multiple Fields.)

UNIVERSITY OF PUERTO RICO, COLLEGE OF AGRICULTURE AND MECHANIC ARTS, 6 weeks, June 6-July 15: *Principles of Radiation Biology; Effect of Radiation on Plant and Animal Ecology; Modern and Atomic Physics; Radiochemistry;* for teachers of biology and physics. Dr. Jose A. Ramos, Department of Biology, College of Agriculture and Mechanic Arts, University of Puerto Rico, Mayaguez, P. R. (SH; 1, 3, 4)

PURDUE UNIVERSITY, 6 weeks, June 13-July 22: *Introduction to Radioactivity; Laboratory Experiments With Radioactivity; Radioactivity in Biology; Health Physics and Radiological Control;* for teachers of science. Dr. John E. Christian, Head, Department of Bionucleonics, Purdue University, West Lafayette, Ind. (SH; 1, 2)

TUSKEGEE INSTITUTE, 8 weeks, June 6-July 30: *Radiation Biology;* for teachers of biology and other sciences. Dr. James H. M. Henderson, Head, Department of Biology, P.O. Box 188, Tuskegee Institute, Ala. (SH; 3, 4)

UNIVERSITY OF WASHINGTON, 8 weeks, June 20-August 12: *Radiation Biology;* for teachers of science. Prof. Arthur D. Welander, University of Washington, Seattle 5, Wash. (SH; 4)

WAYNE STATE UNIVERSITY, 8 weeks, June 27-August 19: *Radiation Biology;* for teachers of science. Dr. Walter Chavin, Department of Biology, Wayne State University, Detroit 2, Mich. (SH; 2, 3, 4)

UNIVERSITY OF WYOMING, 8 weeks, June 20-August 12: *Principles of Biology; Radiology;* for teachers of biology and related sciences. Dr. Carl A. Cinnamon, Department of Physics, University of Wyoming, Laramie, Wyo. (SH; 1, 2, 4)

General Science

COLGATE UNIVERSITY, 6 weeks, June 27-August 6: *Zoology; Botany; Physics; Earth Science; Chemistry; Materials and Equipment in Science;* for teachers of general science. Dr. Oran B. Stanley, Department of Botany, Colgate University, Hamilton, N. Y. (JH; 1)

DEPAUW UNIVERSITY, 6 weeks, June 27-August 5: *General Science and Mathematics;* for teachers of general science. Dr. Donald J. Cook, Department of Chemistry, DePauw University, Greencastle, Ind. (JH; 1)

EASTERN MICHIGAN UNIVERSITY, 6 weeks, June 20-July 29: *Astronomy; Basic Concepts of Classical and Modern Physics; Selected Topics in Mathematics; Introductory Chemistry; Biology of Man; Processes of Land Development;* for teachers of general science. Dr. James M. Barnes, Department of Physics and Astronomy, Eastern Michigan University, Ypsilanti, Mich. (JH, SH; 1)

GRAMBLING COLLEGE, 8 weeks, June 13-August 5: *Problems in Biological Science, Physical Science, and Earth Science;* for teachers of general science. Dr. Archie L. Lacey, Department of Natural Science and Mathematics, Grambling College, Grambling, La. (JH, SH; 1)

INDIANA STATE TEACHERS COLLEGE, 10 weeks, June 13-August 19: *General Science;* for teachers of general science. Dr. John C. Hook, Department of Science, Indiana State Teachers College, Terre Haute, Ind. (JH, SH; 1, 2)

LOUISIANA STATE UNIVERSITY, 9 weeks, June 9-August 13: *Physical Sciences; Biological Sciences;* and *Mathematics;* for teachers of general science. (Director of Program: Prof. H. B. Williams, Louisiana State University.) Dr. John F. Christman, Department of Chemistry, Louisiana State University, Baton Rouge 3, La. (JH, SH; 3)

STATE UNIVERSITY OF SOUTH DAKOTA, 8 weeks, June 13-August 5: *Introductory Mathematics for Science Teachers; General Science Institute Lectures; Laboratory Materials and Techniques for General Science;* for teachers of general science. Prof. M. M. Hasse, Department of Mathematics, State University of South Dakota, Vermillion, S. Dak. (JH, SH; 1, 2)

UNIVERSITY OF TOLEDO, 8 weeks, June 13-August 5: *Modern Developments in Earth Science; Modern Developments in Biological Science; Modern Developments in Physical Science;* for teachers of general science. Prof. Robert R. Buell, University of Toledo, Toledo 6, Ohio. (JH; 1, 2)

VIRGINIA STATE COLLEGE, 8 weeks, June 20-August 12: *Field Biology; Chemistry; Earth Science; Geology; Mathematics; Meteorology; Physics;* for teachers of general science. Dr. Richard H. Dunn, Department of Biology, Virginia State College, Petersburg, Va. (JH, SH; 1)

West Virginia Wesleyan College, 6 weeks, June 19-July 30: *Astronomy; Biology; Chemistry; Geology; Mathematics; Physics;* for teachers of general science. Dr. John C. Wright, Department of Chemistry, West Virginia Wesleyan College, Buckhannon, W. Va. (JH; 1, 2)

Woman's College of the University of North Carolina, 6 weeks, June 6-July 15: *Selected Topics in Biology; Chemistry; Earth Science; Mathematics for Science Teachers; Basic Physics;* for teachers of general science. Dr. Hollis J. Rogers, Department of Biology, Woman's College of the University of North Carolina, Greensboro, N.C. (JH, SH; 1, 2)

University of Wyoming, 8 weeks, June 13-August 5: *General Science;* for teachers of general science. Prof. Palmer O. Steen, Department of Mathematics, University of Wyoming, Laramie, Wyo. (JH, SH; 1, 2)

Multiple Fields

Adelphi College, 6 weeks, July 6-August 16: *Survey of Nuclear Physics and of Newer Concepts in Biology; Tracer Instrumentation; Application of Isotope Techniques to Biology; Biological Effects of Radiation;* for teachers of biology. (Director of Program: Prof. Marie E. Conklin, Adelphi College.) Dr. Howard A. Robinson, Department of Physics, Adelphi College, Garden City, N.Y. (SH; 4)

University of Alabama, 5½ weeks, June 6-July 13: *Physics; Chemistry; Biology; Earth Science;* for teachers of science. Dr. Charles K. Arey, Professor of Education, Box 1608, University, Ala. (SH; 1, 2, 3)

University of Alabama, 5½ weeks, July 14-August 19: *Physics; Chemistry; Biology; Earth Science;* for teachers of science. Dr. Charles K. Arey, Professor of Education, Box 1608, University, Ala. (JH; 1, 2, 3)

Alabama College, 6 weeks, June 6-July 15: *General Biology; General Chemistry; General Physics; Mathematics for the Sciences;* for teachers of biology, chemistry, physics, and general science. Dr. Paul C. Bailey, Biology Department, Alabama College, Montevallo, Ala. (JH, SH; 1, 2)

Alabama Polytechnic Institute, 10½ weeks, June 13-August 25: *Mathematics; Chemistry; Physics; General Science; Botany; Zoology;* for teachers of science and mathematics. Dr. Ernest Williams, Department of Mathematics, Alabama Polytechnic Institute, Auburn, Ala. (JH, SH; 1, 2)

University of Alaska, 8 weeks, June 20-August 12: *The Mathematics Curriculum; Applications of Mathematics; Basic Biology; Basic Chemistry;* and *Basic Physics;* for teachers of science and mathematics. Prof. William R. Cashen, Department of Mathematics, University of Alaska, College, Alaska. (JH; 1, 2)

Albany State College, 6 weeks, June 13-July 22: *Modern Concepts of Physical Science; Earth Science; Biology;* for teachers of general science and biology. Prof. Alexander A. Hall, Box 150, Albany State College, Albany, Ga. (JH, SH; 1, 2)

Allegheny College, 7 weeks, June 27-August 12: *Astronomy; Biology; Chemistry; Geology; Mathematics; Physics;* for teachers of science and mathematics. Dr. Robert E. Bughee, Department of Biology, Allegheny College, Meadville, Pa. (JH, SH; 1, 2)

The American Museum of Natural History, 4 weeks, July 5-August 2, at the Southwestern Research Station, Portal, Ariz.: *Techniques and Methods in Field Geology; Techniques and Methods in Field Zoology;* for teachers of earth science and biology. Mr. Bruce C. Hunter, the American Museum of Natural History, Central Park West and 79th Street, New York 24, N.Y. (SH; 4)

Antioch College, 8 weeks, June 20-August 12: *Earth Science; Biology; Chemistry; Physics; Mathematics;* for teachers of general science and the above subjects. Dr. James F. Corwin, Department of Chemistry, Antioch College, Yellow Springs, Ohio. (JH, SH; 2, 3)

Appalachian State Teachers College, 6 weeks, June 9-July 16: *Chemistry; Biology; Field Biology;* for teachers of science. Dr. I. W. Carpenter, Jr., Department of Biology, Appalachian State Teachers College, Boone, N.C. (SH; 2, 3)

University of Arizona, 8 weeks, June 13-August 6: *Modern Botany; Organic Chemistry; Introduction to Chemical Bond; Intermediate Classical Physics; Foundations of Modern Physics; Genetics and Evolution;* for teachers of science. Prof. M. G. Seeley, Department of Chemistry, University of Arizona, Tucson, Ariz. (SH; 3)

Arizona State College, 8 weeks, June 27-August 19: *Biology; Chemistry; Earth Science; Physics and Mathematics;* for teachers of science and mathematics. Dr. Agnes M. Allen, Director, Division of Science and Mathematics, Arizona State College, Flagstaff, Ariz. (JH, SH; 1, 2)

University of Arkansas, 6 weeks, June 6-July 15: *Biology; Chemistry; Physics;* for teachers of science. Prof. Lowell F. Bailey, Botany and Bacteriology Department, University of Arkansas, Fayetteville, Ark. (JH, SH; 1, 2, 3)

Atlanta University, 9 weeks, June 9-August 8: *Biology; Chemistry; Mathematics; Physical Science;* for teachers of science and mathematics. Dr. K. A. Huggins, Department of Chemistry, Atlanta University, Atlanta 14, Ga. (JH, SH; 2, 3, 4)

Benedict College, 6 weeks, June 6-July 15: *Modern Approach to Biology; Chemistry; Physics; Mathematics;* for teachers of science and mathematics. Dean T. J. Hanberry, Benedict College, Columbia, S. C. (JH, SH; 1, 2)

Birmingham-Southern College, 8 weeks, June 13-August 5: *General Biology; General Physics; General Chemistry; Mathematics; Earth Science; Seminar;* for teachers of science and mathematics. Prof. Wiley S. Rogers, Department of Geology, Birmingham-Southern College, Birmingham, Ala. (JH, SH; 1, 2)

Bradley University, 6 weeks, June 27-August 5: *Basic Concepts of Mathematics; Modern Concepts and Trends in the Biological Sciences; Modern Concepts in Chemistry; Basic Concepts and Recent Trends in Physics;* for teachers of science and mathematics. Dr. A. Wayne McGaughey, Department of Mathematics, Bradley University, Peoria 5, Ill. (JH, SH; 1, 2)

Brown University, 6 weeks, June 27-August 5: *Basic Ideas in Modern Biology; Fundamentals of Chemistry; Modern Mathematics; Fundamental Physics;* for teachers of science and mathematics. Prof. Elmer R. Smith, Brown University, Providence 12, R.I. (JH, SH; 1, 2)

Bucknell University, 6 weeks, June 27-August 5: *Botany; Zoology; Introductory Organic Chemistry; Selected Topics in Chemistry; Elementary Principles of Astronomy; Selected Topics in Mathematics; Selected Topics in Physics;* for teachers of science and mathematics. Dr. Lester Kieft, Department of Chemistry, Bucknell University, Lewisburg, Pa. (JH, SH; 1, 2)

University of California, Berkeley, 7 weeks, June 20-August 5: *Physics; Chemistry; Biology;* for teachers of science. Mr. Robert A. Rice, Engineering and Sciences Extension, 2451 Bancroft Way, Berkeley 4, Calif. (JH, SH; 2, 3)

University of California, Los Angeles, 6 weeks, June 20-July 29: *Modern Aspects of Chemistry and Chemical Education; Modern Aspects of Biology and Life Sciences Education; Fundamental Mathematical Concepts; Demonstrations of Fundamental Physical Principles;* for teachers of science and mathematics. (Director of Program: Dean Francis E. Blacet, University of California, Los Angeles.) Prof. Clifford Bell, Physical Sciences Extension, Room 6501, Engineering II, University of California, Los Angeles 24, Calif. (SH; 1, 2)

Central Connecticut State College, 6 weeks, June 27-August 5: *Elementary Statistics; Fundamental Concepts of Algebra; Introduction to Analysis; Topics in Physics; Topics in Biology; Topics in Chemistry;* for teachers of science and mathematics. Prof. Kenneth G. Fuller, Department of Mathematics, Central Connecticut State College, New Britain, Conn. (JH; 1, 2)

Central Missouri State College, 8 weeks, June 13-August 5: *Biology; Chemistry; Physics; Earth Sciences;* and *Mathematics;* for teachers of science. Dr. Sam P. Hewitt, Department of Biology, Central Missouri State College, Warrensburg, Mo. (JH, SH; 1, 2)

University of Chattanooga, 7 weeks, June 6-July 22: *General Science; Biology; Chemistry; Mathematics; Earth Science; Physics;* for teachers of science or mathematics. Dr. Horace Coulliette, University of Chattanooga, Chattanooga 3, Tenn. (JH, SH; 1, 2)

Chico State College, 6 weeks, June 20-July 29: *Field Zoology; Field Botany; Biology Materials for Teachers; Mathematics for High School Teachers; Analytical Geometry and Calculus; College Geometry; Linear Algebra; Introduction to Nuclear Physics (two levels); Basic and Modern Concepts of Chemistry (two levels);* for teachers of science and mathematics. Dr. Robbins S. King, Department of Biology, Chico State College, Chico, Calif. (JH, SH; 1, 2)

Claflin College, 9 weeks, June 6-August 5: *Biology; Chemistry; Mathematics; Science and Mathematics Education;* for teachers of science and mathematics. Prof. Hampton D. Smith, Sr., Chairman, Division of Science and Mathematics, Claflin College, Orangeburg, S.C. (JH, SH; 1, 2, 3)

Clemson College, 6 weeks, June 13-July 23: *Biology; Principles of Chemistry; Earth Science; Fundamental Concepts in High School Mathematics; Astronomy;* for teachers of science and mathematics. Dr. Floyd I. Brownley, Jr., Department of Chemistry and Geology, Clemson College, Clemson, S.C. (JH, SH; 1-2)

Colby College, 6 weeks, June 27-August 5: *Biological Sciences; Mathematics; Geology; Physical Sciences;* for teachers of science and mathematics. Dr. Evans B. Reid, Department of Chemistry, Colby College, Waterville, Maine. (JH, SH; 1, 2, 3)

Columbia College, 8 weeks, June 27-August 19: *Selected Topics in the Principles of Biology; Entomology (Insects of Field and Stream); Selected Topics in the Principles of Chemistry; Modern Developments in Physics;* for teachers

of biology, chemistry, and general science. Dr. Philip E. Graef, Chairman, Science Department, Columbia College, Columbia, S.C. (JH, SH; 1, 2)

UNIVERSITY OF CONNECTICUT, 6 weeks, July 5-August 12: *Physical Science Study Committee Program; General Science; Biology; Earth Science;* for teachers of physics and science. Dr. David J. Blick, Department of Science Education, U-64, University of Connecticut, Storrs, Conn. (JH, SH; 2, 3)

CONVERSE COLLEGE, 8 weeks, June 13-August 6: *Biology; Chemistry; Physics;* for teachers of biology, chemistry, and physics. Dr. Walter J. Wyatt, Department of Chemistry, Converse College, Spartanburg, S.C. (SH; 1, 2)

UNIVERSITY OF DETROIT, 6 weeks, June 27-August 5: *Frontiers of Biology; Theoretical Chemistry; Perspectives in Biochemistry; A Survey of Atomic and Nuclear Physics; Radiological Physics;* for teachers of biology, chemistry, and physics. Dr. E. L. Henderson, Department of Chemistry, University of Detroit, Detroit 12, Mich. (JH, SH; 1, 2, 3)

DUKE UNIVERSITY, 9 weeks, June 8-August 9: *Biology; Chemistry; Mathematics; Physics;* for teachers of science and mathematics. Dr. Lewis E. Anderson, Department of Botany, Duke University, Durham, N.C. (JH, SH; 1, 2, 3)

EASTERN ILLINOIS UNIVERSITY, 8 weeks, June 13-August 5: *Botany; Chemistry; Physics; Zoology;* for teachers of science. Dr. Weldon N. Baker, Department of Chemistry, Eastern Illinois University, Charleston, Ill. (JH, SH; 1, 2)

EASTERN NEW MEXICO UNIVERSITY, 8 weeks, June 20-August 12: *Special Topics in Biology; Principles of Chemistry; Principles of Geology; Principles of Physics; Mathematics for Science Teachers;* for teachers of biology and general science. Dr. Ruth B. Thomas, Eastern New Mexico University, Portales, N. Mex. (JH, SH; 1, 2)

EAST TENNESSEE STATE COLLEGE, 8 weeks, June 13-August 6: *Biology, Chemistry, or Physics; Recent Advances and Practical Applications of Each;* for teachers of biology, chemistry, or physics. Prof. Douglas G. Nicholson, Department of Chemistry, East Tennessee State College, Johnson City, Tenn. (JH, SH; 1, 2)

FISK UNIVERSITY, 8 weeks, June 13-August 6: *Biology; Chemistry; Physics;* for teachers of biology, chemistry, and physics. Dr. Samuel P. Massie, Department of Chemistry, Fisk University, Nashville, Tenn. (JH, SH; 1, 2)

UNIVERSITY OF FLORIDA, 8 weeks, June 20-August 12: *Biology for Teachers; Special Topics in Botany; Chemistry for Teachers; Mathematics for Junior High School Teachers; or Mathematics for Senior High School Teachers;* for teachers of biology, chemistry, or mathematics. Prof. N. E. Bingham, 148 Norman Hall, University of Florida, Gainesville, Fla. (JH, SH; 2, 3)

FLORIDA STATE UNIVERSITY, 8 weeks, June 11-August 5: *Bacteriology; Plant Anatomy; General Plant Physiology; Biology of Vertebrates; Entomology; Genetics; Physiology of Growth and Development; Marine Science (Survey); Advances in Fundamental Chemistry; Selected Topics in Organic and Biochemistry and Directed Individual Study in Chemistry;* for teachers of biology and chemistry. Prof. Dwight B. Goodner, Department of Mathematics, Florida State University, Tallahassee, Fla. (JH, SH; 2, 3, 4)

GEORGE PEABODY COLLEGE FOR TEACHERS, 10 weeks, June 13-August 19: *Courses in Calculus, Biochemistry; Modern Physics; Developmental Biology; Determinants and Matrices; Statistics; Non-Euclidean Geometry;* for teachers of science and mathematics. Dr. H. Craig Sipe, Department of Physics, George Peabody College for Teachers, Nashville 5, Tenn. (JH, SH; 1, 2, 3)

UNIVERSITY OF GEORGIA, 9 weeks, June 13-August 18: *Elementary Courses in Botany, Chemistry, Physics, and Mathematics (Algebra and Trigonometry);* for teachers of science and mathematics. Dr. T. H. Whitehead, Department of Chemistry, University of Georgia, Athens, Ga. (JH, SH; 1)

UNIVERSITY OF GEORGIA, 6 weeks, June 13-July 20: *Principles of Inorganic and Organic Chemistry; Development of Chemical Theories; Principles of Astronomy and Physics; Field Botany and Entomology; Principles of Algebra and Geometry;* for teachers of science and mathematics. Dr. T. H. Whitehead, Department of Chemistry, University of Georgia, Athens, Ga. (JH, SH; 2)

UNIVERSITY OF HAWAII, 6 weeks, June 20-July 29: *Physical Sciences; Biological Sciences; Modern Mathematics;* for teachers of science and mathematics. Dr. Albert J. Bernatowicz, Science Institute, University of Hawaii, Honolulu 14, Hawaii. (JH, SH; 1, 2)

HOWARD PAYNE COLLEGE, 6 weeks, May 31-July 8: *Biology; Chemistry; Mathematics; Physics;* for teachers of science and mathematics. Dr. Leonard R. Daniel, Science Division, Howard Payne College, Brownwood, Tex. (JH, SH; 1, 2)

HUMBOLDT STATE COLLEGE, 6 weeks, June 20-July 29: *Biology; Chemistry; Earth Science; Physics;* for teachers of science. Mr. E. Charles Parke, Division of Natural Science, Humboldt State College, Arcata, Calif. (JH, SH; 1, 2, 3)

UNIVERSITY OF IDAHO, 8 weeks, June 13-August 5: *Biological Sciences; Physical Sciences; Mathematics;* for teachers of science and mathematics. Dr. Edgar H. Grahn, Department of Physical Sciences, University of Idaho, Moscow, Idaho. (JH, SH; 1, 2, 3)

UNIVERSITY OF ILLINOIS, 8 weeks, June 20-August 13: *Geology; Human Physiology;* for teachers of science. Mr. Roger K. Brown, College of Education, 309 University High School, Urbana, Ill. (JH; 1)

ILLINOIS WESLEYAN UNIVERSITY, 8 weeks, June 13-August 5: *Basic Concepts and Recent Trends in Biology, Chemistry, Physics, and Mathematics; Advanced Seminars and Research Problems in Biology, Chemistry, Physics, and Mathematics;* for teachers of science and mathematics. Dr. Wayne W. Wantland, Division of Science, Illinois, Illinois Wesleyan University, Bloomington, Ill. (SH; 3)

INTER-AMERICAN UNIVERSITY OF PUERTO RICO, 7 weeks, June 6-July 22: *Basic Biology; Principles of General Science; Modern Concepts in Biology and General Science;* for teachers of biology and general science. Prof. Ismael Velez, Inter-American University of Puerto Rico, San German, P.R. (JH, SH; 1, 2)

IOWA STATE UNIVERSITY, 6 weeks, June 15-July 26: *Biology; Chemistry; Mathematics; Physics;* for teachers of science and mathematics. Dr. Orlando C. Kreider, 223 Beardshear Hall, Ames, Iowa. (JH, SH; 2)

KANSAS STATE COLLEGE OF PITTSBURG, 8 weeks, June 13-August 5: *Recent Advances in Botany; Modern Concepts in Chemistry; Basic Concepts of Algebra;* for teachers of science and mathematics. Dr. R. G. Smith, Department of Mathematics, Kansas State College of Pittsburg, Pittsburg, Kans. (JH, SH; 1, 2)

KANSAS STATE TEACHERS COLLEGE, 12 weeks, June 6-August 26: *Botany; Zoology; Chemistry; Physics; General Science; Mathematics;* for teachers of science and mathematics. Prof. Otto M. Smith, Department of Physical Science, Kansas State Teachers College, Emporia, Kans. (SH; 1, 2, 3)

LAFAYETTE COLLEGE, 6 weeks, June 27-August 5: *Selected Topics in Intermediate Inorganic Chemistry; Advanced Laboratory Physics; Finite Mathematics; Probability and Statistics; Physics and Chemistry of the Earth; Origin and Evolution of Life;* for teachers of chemistry, physics, earth sciences, and mathematics. Dr. Fred V. Roeder, Department of Education, Lafayette College, Easton, Pa. (JH, SH; 1, 2, 3)

LOUISIANA STATE UNIVERSITY, 9 weeks, June 9-August 13: *Biology; Chemistry; Physics and Mathematics;* for teachers of science or mathematics. Prof. H. B. Williams, Department of Chemistry, Louisiana State University, Baton Rouge 3, La. (SH; 1, 2)

MACALESTER COLLEGE, 8 weeks, June 13-August 5: *Biology; Chemistry; Geology; Physics; Mathematics;* for teachers of the natural sciences and mathematics. Prof. Russell B. Hastings, Department of Physics, Macalester College, St. Paul 1, Minn. (JH, SH; 2, 3, 4)

UNIVERSITY OF MARYLAND, 7 weeks, June 20-August 5: *Biology; Chemistry; Physics;* for teachers of science. Dr. Joshua C. Brown, Department of Zoology, University of Maryland, College Park, Md. (JH, SH; 1, 2, 3)

MEMPHIS STATE UNIVERSITY, 8 weeks, June 13-August 5: *Recent Advances in General Zoology; Recent Advances in Inorganic Chemistry; Recent Advances in General Mathematics for High School Science Teachers; Recent Advances in Physics; Seminar in Teaching the High School Sciences;* for teachers of science. Prof. J. W. Fox, Chairman, Department of Physical Science, Memphis State University, Memphis 11, Tenn. (SH; 1, 2)

MIDDLE TENNESSEE STATE COLLEGE, 11 weeks, June 6—August 19: *Principles of Modern Biology; Botany of Flowering Plants; Intermediate General Chemistry; Topics in Analytical Chemistry; Basic Concepts in Mathematics; Selected Topics of Modern Mathematics; Fundamentals of Physics; Light and Optics;* for teachers of science and mathematics. Dr. J. Eldred Wiser, Department of Science, Middle Tennesee State College, Murfreesboro, Tenn. (SH; 1, 3)

MISSISSIPPI SOUTHERN COLLEGE, 9 weeks, June 13—August 12: *Biology; Chemistry; Mathematics; Physics;* for teachers of science and mathematics. Prof. B. O. Van Hook, Department of Mathematics, Mississippi Southern College, Hattiesburg, Miss. (JH, SH; 1, 2)

MOREHEAD STATE COLLEGE, 8 weeks, June 13—August 5: *Fundamentals of Biological Science; Entomology; Biological Concepts; Modern Theories of Evolution; Fundamentals of Chemistry; Fundamentals of Physics; Introduction to Atomic Physics; Physical Concepts; Fundamentals of Mathematics; Theory of Equations;* for teachers of science and mathematics. Dr. William B. Owsley, Divison of Science and Mathematics, Morehead State College, Morehead, Ky. (JH, SH; 1, 2)

MORGAN STATE COLLEGE, 6 weeks, June 20—July 29: *Astronomy; Basic Principles of Biology; Basic Concepts of Modern Chemistry; Fundamental Concepts of Mathematics; Basic Principles of Physics; Seminar in Modern Aspects of Teaching High School Science and Mathematics;* for teachers of

science and mathematics. Prof. Thomas P. Fraser, Department of Science Education, Morgan State College, Baltimore 12, Md. (JH, SH; 2, 3)

MURRAY STATE COLLEGE, 8 weeks, June 13—August 5: *Basic Biological Science; Principles of Chemistry; principles of Physics; Fundamental Earth Science; Recent Developments in Chemistry; Recent Developments in Physics; Biological Sciences for High School Teachers; Theory of Probability; Mathematical Analysis;* for teachers of science and mathematics. Dr. Alfred Wolfson, Murray State College, Murray, Ky. (JH, SH; 1, 2)

UNIVERSITY OF NEBRASKA, 8 weeks, June 6—July 29: *Courses in Biology, Chemistry, History of Science, Mathematics and Physics;* for teachers of science and mathematics. Dr. John R. Demuth, 210 Avery Laboratory, University of Nebraska, Lincoln 8, Nebr. (SH; 1, 2, 3)

NEW MEXICO STATE UNIVERSITY, 8 weeks, June 13—August 5: *Biology; Chemistry; Mathematics; Physics;* for teachers of science and mathematics. Dr. E. L. Cleveland, Department of Physics, New Mexico State University, University Park, N. Mex. (JH, SH; 1, 2, 3)

STATE UNIVERSITY OF NEW YORK, COLLEGE OF EDUCATION AT ALBANY, 6 weeks, July 5—August 12: *Biology; Chemistry; Earth Science; Physics;* for teachers of science. Dr. Edgar W. Flinton, Director of Graduate Studies, New York State College for Teachers, Albany, N.Y. (JH, SH; 2, 3)

STATE UNIVERSITY OF NEW YORK, COLLEGE OF EDUCATION AT ONEONTA, 6 weeks, July 4—August 12: *Mathematics; Biology; Physics; Chemistry; Earth Science;* for teachers of science and mathematics. Dr. Emery L. Will, Department of Science, State University College of Education, Oneonta, N.Y. (JH, SH; 1, 2, 3)

STATE UNIVERSITY OF NEW YORK, COLLEGE OF EDUCATION AT POTSDAM, 6 weeks, July 5—August 12: *Biology; Chemistry; Earth Science; Physics;* for teachers of science. Dr. Alexander G. Major, State University College of Education, Potsdam, N.Y. (JH; 1)

AGRICULTURAL AND TECHNICAL COLLEGE OF NORTH CAROLINA, 6 weeks, June 13—July 22: *Animal Biology; Plant Biology; Advanced General Chemistry; Recent Advances in Chemistry; Advanced General Physics;* for teachers of biology, chemistry, and physics. Dr. Gerald A. Edwards, Department of Chemistry, Agricultural and Technical College of North Carolina, Greensboro, N.C. (SH; 1, 2)

UNIVERSITY OF NORTH CAROLINA, 6 weeks, June 13—July 22: *Botany, Zoology, Chemistry, Physics, Mathematics;* for high school teachers of science and mathematics. Prof. Victor A. Greulach, 210 Venable, University of North Carolina, Chapel Hill, N.C. (SH; 1, 2)

NORTH CAROLINA COLLEGE AT DURHAM, 6 weeks, June 14—July 24: *Biology; Chemistry; Mathematics;* for teachers of biology, chemistry, and mathematics. Dr. William H. Robinson, Department of Physics, North Carolina College at Durham, Durham, N.C. (SH, 3, 4)

NORTH DAKOTA AGRICULTURAL COLLEGE, 8 weeks, June 13—August 5: *Chemistry; Biochemistry; Mathematics; Physics; and Zoology;* for teachers of science and mathematics. Dr. F. L. Minnear, School of Chemical Technology, North Dakota Agricultural College, Fargo, N. Dak. (JH, SH; 1, 2, 3)

NORTHEAST LOUISIANA STATE COLLEGE, 9 weeks, June 7—August 10: *Practical Aspects and Current Developments in Biology and Chemistry;* for teachers of science. Dr. Aaron Seamster, Head, Department of Biology, Northeast Louisiana State College, 4001 De Siard Street, Monroe, La. (SH; 1, 2)

NORTHERN MICHIGAN COLLEGE, 6 weeks, June 20—July 29: *Seminar in Chemistry; Seminar in Physics; Evolution, Insects, Parasitology, Fundamentals of Public Health; Seminar in Mathematics, Advanced Calculus, Topics in Algebra;* for teachers of chemistry, physics, biology, or mathematics. Prof. Holmes Boynton, Northern Michigan College, Marquette, Mich. (SH; 1 2, 3)

NORTH TEXAS STATE COLLEGE, 6 weeks, June 6—July 14: *Elementary Analysis; Selected Topics in Algebra; Basic Concepts in Mechanics, Wave Motion and Kinetic Theory; Basic Concepts and Applications in Electricity and Electronics; Recent Developments in Chemistry; Basic Concepts in Environmental Biology;* for teachers of science and mathematics. Dr. Robert C. Sherman, Box 6045, North Texas State College, Denton, Tex. (JH, SH; 1, 2)

THE OHIO STATE UNIVERSITY, 8 weeks, June 20— August 12: *Principles of Mathematics; Fundamental Ideas in Analysis; Recent Advances in Chemistry; Basic Bacteriology; Radiation Biology;* for teachers of science and mathematics. Dr. John S. Richardson, Department of Education, The Ohio State University, Columbus 10, Ohio. (JH, SH; 2, 3, 4)

OHIO WESLEYAN UNIVERSITY, 8 weeks, June 20—August 12: *Astronomy; Botany; Chemistry; Geology; Physics, Zoology;* for teachers of science. Dr. Leonard N. Russell, Department of Physics, Ohio Wesleyan University, Delaware, Ohio. (JH, SH; 1, 2)

UNIVERSITY OF OKLAHOMA, 8 weeks, June 6—July 30: *Foundations of Natural Science Given as a Seminar in Philosophy and Research Problems in History of Science;* for teachers of science and /or mathematics. Dr. H. H. Bliss, 61 Faculty Exchange, University of Oklahoma, Norman, Okla. (JH, SH; 2, 3)

UNIVERSITY OF OKLAHOMA, 8 weeks, June 6—July 30: *Recent Developments in Mathematics and the Sciences;* for teachers of biology, chemistry, mathematics and physics. Dr. H. H. Bliss, 61 Faculty Exchange, University of Oklahoma, Norman, Okla. (JH, SH; 2, 3, 4)

OKLAHOMA STATE UNIVERSITY, 9 weeks, June 6—August 6: *Principles and Concepts in Biology; Courses from the Areas of Botany, Chemistry, Bacteriology, Entomology, Physiology, Physics, and Zoology;* for teachers of biology. (Director of Program: Dr. Imy V. Holt, Oklahoma State University.) Dr. James H. Zant, Department of Mathematics, Oklahoma State University, Stillwater, Okla. (SH; 4)

OREGON STATE COLLEGE, 8 weeks, June 20—August 12: *Fundamental Concepts and Recent Advances in Botany; in Zoology; in Chemistry; in Mathematics; in Physics;* for teachers of general science, biological and/or physical science, and mathematics. Dr. Stanley E. Williamson, Department of Science Education, Oregon State College, Corvallis, Ore. (JH, SH; 1, 2, 3)

UNIVERSITY OF PENNSYLVANIA, 6 weeks, June 27—August 5; *Botany; Chemistry; Mathematics; Microbiology; Physics; and Zoology;* for teachers of science and mathematics. Prof. J. F. Hazel, Harrison Laboratory, University of Pennsylvania, Philadelphia 4, Pa. (JH, SH; 1, 2)

THE PENNSYLVANIA STATE UNIVERSITY, 6 weeks, July 5—August 12: *Biological Sciences; Chemistry; Earth Sciences; Mathematics; Physics; PSSC;* for teachers of science and mathematics. Prof. William H. Powers, The Pennsylvania State University, 214 Whitmore Laboratories, University Park, Pa. (JH, SH; 1, 2, 3)

PRAIRIE VIEW A. & M. COLLEGE, 6 weeks, June 5—July 16: *Biology; Chemistry; Mathematics; Physics;* for teachers of science and mathematics. D. E. E. O'Banion, Head, Department of Natural Sciences, Prairie View A. & M. College, Prairie View, Tex. (JH, SH; 1, 2)

RANDOLPH-MACON WOMAN'S COLLEGE, 6 weeks, June 22—August 3: *Algebra; Geometry; Human Biology; Chemistry;* and *Physics;* for teachers of science and mathematics. Dr. Paul A. Walker, Department of Biology, Randolph-Macon Woman's College, Lynchburg, Va. (SH; 2, 3)

UNIVERSITY OF REDLANDS, 9 weeks, June 20—August 19: *Basic Physiology and Quantitative Biology; Foundations of Mathematics and Topics in Modern Mathematics;* for teachers of biology and mathematics. Dr. Judson Sanderson, Department of Mathematics, University of Redlands, Redlands, Calif. (JH, SH; 1, 2, 3)

RENSSELAER POLYTECHNIC INSTITUTE, 8 weeks, July 5—August 27: *Chemistry; Physics; Geology; Astronomy; Biology; Mathematics;* for teachers of chemistry, physics, and science. Prof. A. A. K. Booth, Director, Division of Special Programs, Rensselaer Polytechnic Institute, Troy, N.Y. (SH; 2, 3)

SACRAMENTO STATE COLLEGE, 6 weeks, June 20—July 29: *Introduction Study of Logic and Abstract Algebra; Implications of Modern Viewpoint of Mathematics for High School Mathematics Programs; Probability and Statistics; Principles and Recent Advances in Biology, Chemistry and Physics;* for teachers of biology, chemistry, mathematics, and physics. Dr. Carl E. Ludwig, Chairman, Division of Science and Mathematics, Sacramento State College, 6000 J St., Sacramento 19, Calif. (JH, SH; 1, 2)

SAINT AUGUSTINE'S COLLEGE, 6 weeks, June 20—July 29: *Modern Concepts of Biology; Modern Aspects of Earth Sciences; Modern Aspects of Inorganic Chemistry; Modern Physics;* for teachers of science. Dean Prezell R. Robinson, Saint Augustine's College, Raleigh, N. C. (JH, SH; 1)

SAINT CLOUD STATE COLLEGE, 5 weeks, July 25—August 26: *Biology; Chemistry; Physics;* for teachers of biology, chemistry, physics, and general science. Dr. Harold Hopkins, Department of Biology, Saint Cloud State College, St. Cloud, Minn. (JH, SH; 1, 2)

SOUTH CAROLINA STATE COLLEGE, 8 weeks, June 13—August 5: *Biology, Chemistry, and Physics;* for teachers of biology, chemistry, general science, and physics. Dr. George W. Hunter, Department of Natural Sciences, South Carolina State College, Orangeburg, S. C. (SH; 1, 2)

STATE UNIVERSITY OF SOUTH DAKOTA, 8 weeks, June 13—August 5: *Biological Sciences; Chemistry; Geology; Mathematics; Physics;* for teachers of science and mathematics. Prof. M. M. Hasse, Department of Mathematics, State University of South Dakota, Vermillion, S. Dak. (JH, SH; 1, 2)

SOUTH DAKOTA STATE COLLEGE, 8 weeks, June 13—August 5: *Botany; Chemistry; Mathematics; Physics; Zoology;* for teachers of mathematics and science. Prof. Kenneth E. Howard, Department of Chemistry, South Dakota State College, Brookings, S. Dak. (JH, SH; 1, 2)

SOUTHERN UNIVERSITY, 8 weeks, June 6—July 29: *Biology; Chemistry; Earth Sciences; Mathematics;* and *Physics;* for teachers of science and mathematics. Dr. J. Warren Lee, Department of Biology, Southern University, Baton Rouge, La. (JH, SH; 1, 2)

SOUTHWESTERN LOUISIANA INSTITUTE, 9 weeks, June 6—August 5: *Bacteriology; Biology; Chemistry; Mathematics; Physics;* for teachers of science. Dr. James R. Oliver, Box 133, SLI Station, Lafayette, La. (JH, SH; 1, 2)

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS, 6 weeks, June 6—July 15: *Astronomy; Biology; Chemistry; Mathematics; Intermediate College Physics;* for teachers of science and mathematics. Prof. C. M. Loyd, Department of Physics, Agricultural and Mechanical College of Texas, College Station, Tex. (JH, SH; 1, 2)

THE UNIVERSITY OF TEXAS, 9 weeks, June 14—August 18: *Biology; Chemistry; General Science; Mathematics; Physics;* for teachers of science and mathematics. Dr. Addison E. Lee, Director, Science Education Center, The University of Texas, Austin 12, Tex. (JH, SH; 1, 2, 3)

TEXAS CHRISTIAN UNIVERSITY, 6 weeks, June 6—July 15: *Advanced General Physics; Principles and Applications of Chemistry; Advanced General Biology; Foundations and Current Trends in Mathematics;* for teachers of physics, chemistry, biology, and mathematics. Dr. Ben T. Goldbeck, Jr., Department of Mathematics, Texas Christian University, Fort Worth 29, Tex. (SH; 1, 2, 3)

TEXAS SOUTHERN UNIVERSITY, 12 weeks, June 6—August 28: *Basic Principles and Recent Advances in Biology, Chemistry, Mathematics, and Physics;* for teachers of biology, chemistry, mathematics, and physics. Dr. Robert J. Terry, Department of Biology, Texas Southern University, Houston 4, Tex. (JH, SH; 1, 2)

TEXAS WOMAN'S UNIVEESITY, 6 weeks, June 8—July 15: *Summer Institute for Teachers of Secondary School Science and Mathematics;* for teachers of biology, chemistry, and mathematics. Dr. Harold T. Baker, Department of Chemistry, Texas Woman's University, Denton, Tex. (JH, SH; 1, 2, 3)

THIEL COLLEGE, 6 weeks, June 26—August 6: *Classical and Contemporary Physics; General Chemistry; Biology (Ecology); Trigonometry and Analytical Geometry:* for teachers of physics, chemistry, biology, and mathematics. Dr. Bela G. Kolossvary, Department of Physics, Thiel College, Greenville, Pa. (SH; 1, 2)

UNION COLLEGE, 8 weeks, June 27—August 19: *Biology; Chemistry; Geology; Mathematics; Physics;* for teachers of science and mathematics. Dr. D. K. Baker, Department of Physics, Union College, Schenectady 8, N.Y. (JH, SH; 1, 2)

UTAH STATE UNIVERSITY, 10 weeks, June 13—August 19: *Basic Concepts of Biology; Modern Physical Science; Basic Mathematics From an Advanced Viewpoint;* for teachers of general science and mathematics. Prof. Joe Elich, Department of Mathematics, Utah State University, Logan, Utah. (JH; 1)

VANDERBILT UNIVERSITY, 8 weeks, June 6—July 29: *Biology; Chemistry; Physics; Mathematics;* for teachers of science and mathematics. Prof. E. Baylis Shanks, Department of Mathematics, Box 1645, Vanderbilt University, Nashville 5, Tenn. (JH, SH; 3, 4)

UNIVERSITY OF VIRGINIA, 8 weeks, June 27—August 20: *Biology; Chemistry; Earth Science; Nuclear Reactors; Physics; Mathematics;* for teachers of science and mathematics. Dr. James W. Cole, Jr., P.O. Box 3697, University Station, University of Virginia, Charlottesville, Va. (JH, SH; 1, 2)

VIRGINIA POLYTECHNIC INSTITUTE, 8 weeks, June 16—August 11: *Advanced Principles of Biology; Earth Science; Fundamental Mathematics for Science Teachers; Principles of Chemistry; General Physics; Problems in Science Teaching;* for teachers of science and mathematics. Dr. Robert C. Krug, Department of Chemistry, Virginia Polytechnic Institute, Blacksburg, Va. (SH; 1, 2)

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